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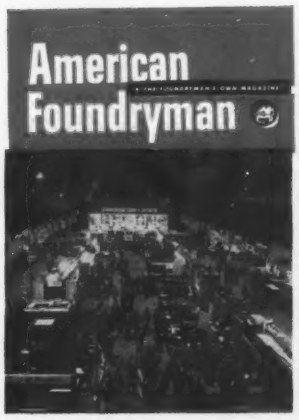

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View of the Arena floor taken from the balcony of the Cleveland Public Auditorium during the A.F.A. Golden Jubilee Foundry Congress and Foundry Show. This scene shows part of the six acres of exhibits which were seen by 20,000 foundrymen during the five day Congress. This exhibit surpassed any previous show sponsored by A.F.A. and was acclaimed the finest foundry show ever staged.

★ MAY WHO'S WHO ★

H. F. Taylor

Co-author, with H. F. Bishop and R. C. Wayne, of *"Copper and the Steel Casting an Alloy for Postwar Consideration"* . . . Mr. Taylor was born in Leslie, Mich. . . . Received his Bachelor of Science and Master of Science degrees from Michigan State College of Agriculture and Applied Science, East Lansing . . . At present research associate at Massachusetts Institute of Technology, Cambridge, he was formerly of the Naval Research Laboratory, Washington, D. C. . . . Started his career with the Michigan State Highway Department as a clerk . . . Was associated with Michigan State College, foundry department, as molding instructor and was later appointed instructor in the metallurgy department . . . Became affiliated with the Michigan Sugar Co., Lansing, and shortly thereafter joined the Naval Research Laboratory staff . . . Was presented the first Peter L. Simpson award at the 50th Anniversary A.F.A. Convention "for his unfailing interest in and contributions to foundry research" . . . Has served on numerous A.F.A. committees . . . Is a well known technical speaker and his findings have been published by the trade press here and abroad . . . Has served as a director, vice-chairman and chairman of the Chesapeake chapter . . . Is a member of A.F.A., AIME, ASM, Institute of Metals (British), Society of Naval Engineers and Washington Society of Engineers.

H. F. Bishop

See: *"Copper and the Steel Casting an Alloy for Postwar Consideration"* . . . Co-author with H. F. Taylor and R. C. Wayne, Mr. Bishop was born in Lansing, Mich. . . . Received his Bachelor of Science degree (1936) in chemical engineering from Michigan State College of Agriculture and Applied Science, East Lansing, Mich. . . . Following graduation became connected with Rademaker Chemical Corp., Manistee, Mich., as chemist . . . Affiliated with Seagrams Distillery Corp., Louisville, Ky., as production engineer, 1937-40 . . . In 1940 joined the Naval Research Laboratory staff as metallurgist . . . Holds membership in A.F.A., ASM and Washington Society of Engineers.

W. J. Bradley

The author is foundry foreman, Dominion Engineering Works, Ltd., Lachine, Que., Canada . . . Born in Port Hope, Ont. . . . Has completed an extension course in metallurgy from McGill University, Montreal, and a mechanical drawing correspondence course . . . Served his apprenticeship in the Bradley Foundry, Paris, Ont., (1926-30) . . . Was appointed assistant manager in 1930 . . . Four years later (1934) became manager . . . Assumed his present position with Dominion in 1937 . . . Has spoken before the Eastern Canada and Newfoundland chapter on grading of foundry sands . . . Present paper, published herein, deals with *"Pressure Feeding Iron Castings"* . . . Member of A.F.A. and ASM.

A. W. Gregg

Author of *"50 Years of Progress in Foundry Steel Melting"* . . . Born in Riverside, Ill. . . . Is a graduate of Purdue University, West La Fayette, Ind., receiving his Bachelor of Science degree in 1903 and Master of Science degree a year later . . . Began his engineering career with Latrobe Steel Co., Melrose Park, Ill., in 1904 as metallurgist . . . Became associated with Whiting Corp., Harvey, Ill., in 1919, as foundry superintendent and remained there until 1923 . . . Was named foundry superintendent for Bucyrus-Erie Co., South Milwaukee, Wis., following a number of years service . . . From 1929-36 was superintendent Bonney Floyd Co., Columbus, Ohio . . . Rejoined Whiting Corp. in 1936 and assumed his present position of executive engineer, foundry equipment division . . . Has spoken before a number of A.F.A. chapters on cupola operation and cupola charging equipment . . . A frequent contributor to the trade press both here and abroad . . . A member of the A.F.A. Cupola Research Project, he also is active in the Chicago chapter . . . Besides his membership in A.F.A. he is an AIME and ASM member.

E. C. Zirzow

In this issue, Mr. Zirzow presents a discussion on *"Malleable Core Making Practice"* . . . Born in Cleveland, the author received his early schooling there . . . Is working at the present time toward a degree in chemical engineering at a Cleveland college . . . Began his industrial career with National Malleable & Steel Castings Co., Cleveland, 1924 . . . At present is core room foreman . . . Has been extremely active in the A.F.A. Foundry Sand Research Project . . . Is a member of the Project's Executive Committee; Committee on Grading and Fineness and Subcommittee on Physical Properties of Iron Foundry Molding Materials at Elevated Temperatures . . . Also is Chairman, Core Test Committee . . . An A.F.A. member.

R. C. Wayne

R. C. Wayne, metallurgist, Naval Research Laboratory, Washington, D. C., is co-author with H. F. Taylor and H. F. Bishop of *"Copper and the Steel Casting an Alloy for Postwar Consideration"* . . . Born in New York, June 22, 1918 . . . A graduate of Rennsselaer Polytechnic Institute, Troy, N. Y., he was awarded his Bachelor of Science degree in chemistry (1939) . . . Joined New York Testing Laboratories, Inc., New York, 1940, as chemist and metallurgist . . . Early in 1941 became assistant foreman, heat treating department, Crucible Steel Co., Harrison, N. J. . . . From 1941-43 was

associated with Babcock & Wilcox Co., Barberton, Ohio, as metallurgist . . . Was commissioned into the United States Naval Reserve in 1943 and was assigned to the Naval Research Laboratory as metallurgist . . . Discharged as a naval lieutenant (1946), he assumed his affiliation with the laboratory in a civilian capacity . . . Has written previous papers for the Association dealing with design of test coupons for cast steel . . . A member of A.F.A. and ASM.

R. J. Maenner

In this issue see: *"Centrifugal Casting of a Magnesium Part"* . . . Written jointly with F. P. Strieter . . . Mr. Maenner was born in Chicago . . . Attended Illinois Institute of Technology, Chicago, and in 1942 graduated with a Bachelor of Science degree in chemical engineering . . . Following college he joined Dow Chemical Co. as metallurgist . . . Holds membership in A. F. A.

F. P. Strieter

A native of Chelsea, Mich., Mr. Strieter has been a member of the metallurgical research department, Dow Chemical Co., Midland, Mich., for the past four years . . . Received his Bachelor of Science degree in metallurgical engineering from the University of Michigan, Ann Arbor, in 1940 . . . Joined the Chase Brass & Copper Co., Waterbury, Conn., and remained there until 1942 when he assumed his present position with Dow Chemical Co. . . . Member of A.F.A. . . . Co-author with R. J. Maenner of *"Centrifugal Casting of a Magnesium Part."*

Our Contributors

AMONG THE HOST of foundry leaders who contributed to technical sessions of the Golden Jubilee Congress were many—far too many to list here—who have become well known to foundrymen through appearance in the pages of this *Who's Who* department.

AMERICAN FOUNDRYMAN, proud of its continuous association with the advance of foundry technology, salutes these honored contributors; and pledges to the membership of A.F.A. that the editorial standards which bring to these pages articles by outstanding leaders in the field, will be maintained.

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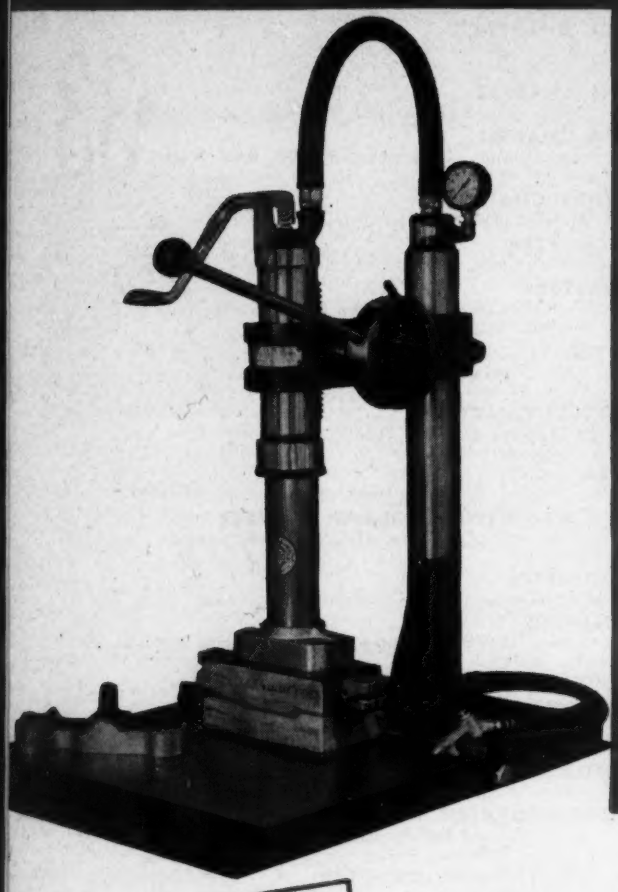
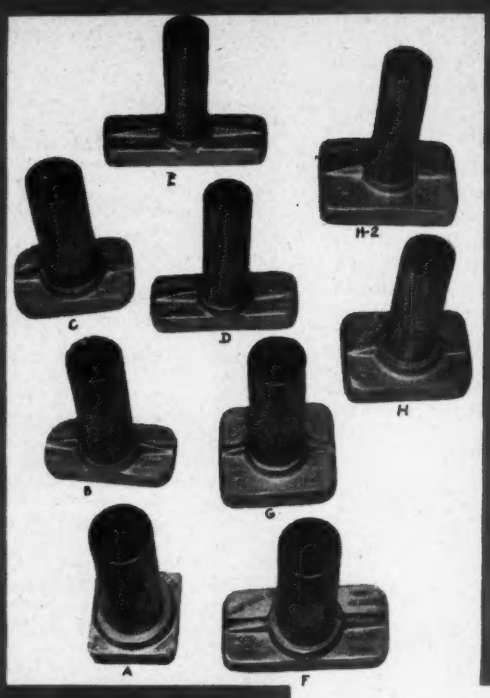
K EFFICIENT PRODUCTION OF SMALL, INTRICATE CORES





1. Core Box Clamping Attachment for blowing vertically split core boxes (Fig. and F)
2. Core Box Drawing Attachment—used with No. 1 for drawing difficult cores.
3. Vibrator and Knee Valve — air or electric furnished with No. 2.

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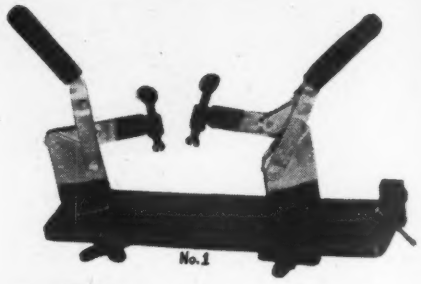
The Standard Sand Cartridges are a cast aluminum base into which a seamless steel tubing (2½" or 2¾" Dia. x 8" long) is pressed. The bottom of the base is closed with an ¼" cold rolled steel plate, in which holes are to be drilled to match the blowholes of the core box.

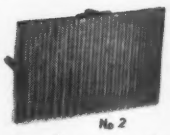
SIZES	WIDTH—LENGTH	PRICE
A	3⅛ x 3⅛	$10.00
B	2¼ x 5⅛	11.00
C*	3 x 5⅛	11.00
D	2¼ x 7¼	12.00
E	2⅝ x 8⅜	12.00
F	3 x 7⅛	14.00
G	4⅜ x 5¼	14.00
H	4⅜ x 6⅜	15.00
H2	4¼ x 7¼	15.00

To find outside dimensions, add ¾" to width and length of inside dimension.

Special size Sand Cartridges furnished upon application.

*This size adaptable to a large range of core boxes.





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Quickly and economically installed. Does not require a large volume of air—½ c f.m is sufficient.

A ¾ inch air line with 80 to 120 lbs. pressure is ample to make cores in single or gang boxes requiring a maximum of 2 lbs. of sand.

To blow core boxes of different height, shape or size, adjustments may be made instantly by the operator.

The Improved REDFORD Core Blower, Cartridge Bench Type, has an arm support column at the rear which provides an air reservoir to give additional volume of air per blow. Blow gun at base of column assures dry air at all times All condensation in reservoir may be removed when using blow gun.

Sand Cartridges are made a part of the core box equipment. The base of a cartridge is determined by the blowholes in the box. However, one cartridge may be used for several core boxes of approximately the same size. The cylindrical part of the cartridge must be high enough from the base to hold sufficient sand to fill the core box once.

HAT USERS SAY

Enclosed check $895.00, which we send th pleasure. We thank you for your interest id print on this core, which was blown perctly as per your instructions. An additional rder is placed for 550 more castings and we will consider the machine paid for

We purchased a Redford cartridge bench core blower eight months ago and in that time we have saved its cost many times in labor savings.

An experienced core maker is not necessary to operate it efficiently

It is adaptable to all small work and easy to set up

The relatively small commission you will make from the sale of this core blower will never free you from the necessity of working like hell to make a living. However, if everything you sell gives the same service and satisfaction that this core blower is giving us, you will inevitably obtain such freedom, but soon.

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The initial investment being so small, it was no time when the blower paid for itself. Production increased tremendously and because of the wide range even short runs are being blown.

*Names of these endorsers furnished upon request

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PRESIDENT HONORS FOUNDRYMEN

Greeting from the President of the United States was extended to A.F.A. President Fred J. Walls in observance of the A.F.A. Golden Jubilee Congress. The letter is shown below.

THE WHITE HOUSE
WASHINGTON

May 2, 1946

Dear Mr. Walls:

I wish you would pass on to the members of the American Foundrymen's Association my heartiest congratulations on the occasion of your golden jubilee congress. The members of the castings industry have good reason to be proud of their contributions to the winning of the war but I am sure that you are thinking less about what you did during the war than about what you can contribute to the growth and prosperity of American industry during the period that lies ahead of us.

The United States needs your energetic cooperation in the achievement of full production and full employment. Nothing less than this vigorous cooperation with all other groups in the country will achieve the kind of future that this country must have to carry out its obligations to its own people and to the world.

Accept my sincere best wishes for a highly successful conference and for prosperous years ahead.

Very sincerely yours,

Harry Truman

Mr. F. J. Walls,
President,
American Foundrymen's Association,
Statler Hotel,
Cleveland, Ohio.

A.F.A. MEMBERS ELECT NEW

OFFICERS AND DIRECTORS

ENTHUSIASTICALLY endorsing the recommendations of its Nominating Committee, the membership of A.F.A., at the Annual Business Meeting held Thursday, May 9, during the Golden Jubilee Foundry Congress in Cleveland, elected a group of its most outstanding leaders to participate in guidance of the Association into an immediate future expected to witness great accomplishments in foundry production and technology.

As a result of the election, A.F.A. now includes in its Directorate a representative of each of its six technical divisions; and the Association again has placed at its helm a President and Vice-President long identified with the activities and objectives of A.F.A.

S. V. Wood

SHELDON V. WOOD, president and general manager, Minneapolis Electric Steel Castings Co., Minneapolis, was elected President of the American Foundrymen's Association for 1946-47 at the recent Golden Jubilee Foundry Congress. Having served as National Vice-President and as National Director, Mr. Wood has become well versed in the Association's technical, educational and chapter activities. He has actively participated in the National Educational Program, and has been a frequent chapter visitor.

A graduate of the University of Minnesota, Minneapolis, although born in Iowa. He obtained his mining engineering degree, 1904, embarked upon his engineering career and saw service with the Great Northern Railroad, Seager Engineering Co., Lansing, Mich., and as a Consulting Engineer in Minneapolis.

He became associated with the foundry industry in 1913, through his present company affiliation, and is one of the most enthusiastic executives in the foundry business. A member of the former Twin City Foundrymen's Association, he was one of those responsible for its becoming an A.F.A. chapter and served as a member of the chapter's Board of Directors. Later, he was elected Vice-Chairman and Chairman of the Twin City chapter.

Last year, as National Vice-President, he served as chairman of the Membership and Chapter Contacts Committees as well as chairman of the Advisory Committee, Technical Development Program. Mr. Wood is also a member of the Executive and Finance Committees.

Aside from his affiliation with the A.F.A., Mr. Wood holds membership in the AIME, ASM, the Steel Founders' Society of America and the Minneapolis Engineers' Society. Recently served as a Vice-President of the Steel Founders' Society of America and is serving on the Board of Regents, University of Minnesota.

Max Kuniansky

MAX KUNIANSKY, vice-president and general manager, Lynchburg Foundry Co., Lynchburg, Va., and a past National Director of the A.F.A., has been named National Vice-President of the American Foundrymen's Association. One of the most active members of the Association, he has served on a large number of A.F.A. technical committees. He is Chairman of both the Finance Committee and the Sub-Committee on Scrap, Cupola Research Project. Mr. Kuniansky also is Vice-Chairman of the A.F.A. committee cooperating with the U. S. Ordnance

S. V. Wood

Max Kuniansky

Department, a member of the Committee on Fluidity, Foundry Sand Research Project, Sub-Committee on Engineering Practice, Symposium and Committee on High Temperature Properties of Cast Iron, Gray Iron Division.

Mr. Kuniansky has long been interested in chapter affairs and has served as a member of the Board of Directors of the Chesapeake chapter. He was awarded the William H. McFadden Gold Medal of A.F.A. in 1941 for outstanding contributions to the foundry industry.

Born in Russia, Max Kuniansky came to this country at an early age and attended the Georgia School of Technology, Atlanta, Ga., graduating in 1919 with a Bachelor of Science degree in chemical engineering, one of the youngest graduates of that technical school. Following his graduation, he was connected for a time with the Aetna Explosive Co., now the Hercules Powder Co., at their Birmingham, Ala., and Ishpeming, Mich., plants. He also has been associated with the National Malleable & Steel Castings Co., Cicero, Ill., and with the American Cast Iron Pipe Co., Birmingham, Ala.

In 1923 he joined the staff of the Lynchburg Foundry Co., Lynchburg, Va., as chief chemist, retaining that position until 1928 when he was named works manager. Later, he became vice-president and general manager of the company.

F. J. Walls

FRED J. WALLS, metallurgist, International Nickel Co. Inc., Detroit, retiring National President, has been elected National Director, to serve a one-year term on the A.F.A. Board.

Including also in his A.F.A. national activities background service as National Vice-President (1944-45) and Director (1939-1942), Mr. Walls needs no introduction to members of the Association. He long has been a frequent and popular speaker at A.F.A. chapters, during his tenures in the foregoing offices and at preceding and intervening periods while engaged as member or chairman of many committees in the Gray Iron Division, of which he has been General Chairman.

A native of Oakland, Michigan, Fred Walls received his technical education at the University of Michigan, Ann Arbor, specializing in metallurgy; and joined Wilson Foundry and Machine Co., Pontiac, Mich., on leaving that school. After advancing to the position of chief metallurgist with the Wilson company, he moved to Eaton-Erb Foundry Co., Vassar, Mich., as metallurgist, before commencing his present association in 1935.

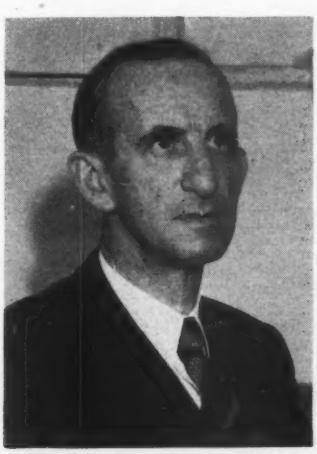
A past President of the former Detroit Foundrymen's Association, now Detroit chapter, A.F.A., Mr. Walls also served as Chapter Director; and, in addition, is active in SAE, ASM, ASTM and Engi-

(Continued on Page 32)

F. J. Walls

B. L. Simpson

H. A. Deane



H. G. Lamker

S. C. Wasson

J. E. Kolb

A.F.A. GOLD JUBILEE CONGRESS HIGHLIGHTS

GOLDEN ANNIVERSARY—this 50th Annual Meeting of the American Foundrymen's Association, May 6 to 10, 1946, was away to an auspicious start in Cleveland, an area comparatively unaffected by the coal shortage and "dim-outs" experienced in other sections of the country. Eighteen thousand representatives from all branches of the industry registered at the Cleveland Public Auditorium, by far the largest attendance in A.F.A. history. An international note, missing during war years, was lent by the presence of representatives from 24 nations.

Round Table Luncheon

Outstanding authorities in the various branches of the industry brought the latest developments in foundry techniques and metallurgi-

cal progress to the numerous technical sessions and committee meetings.

Six acres of exhibit space, displaying an unparalleled array of new equipment and materials for the industry, was a scene of constant activity throughout the meeting.

Technical Sessions

Discussing the heat treating of die castings and degassification of magnesium, the Aluminum and Magnesium Division opened its initial session at the Golden Anniversary Congress with a luncheon. A general discourse on fluxes and mechanical properties of magnesium was brought about through a paper written by Mikoff Corson, consultant, Acme Aluminum Alloys, Dayton, Ohio, on "Aluminum and Magnesium Alloys in Industry and Science."

A joint meeting sponsored by Safety and Hygiene and Plant and Plant Equipment Committees opened with a well attended afternoon session on Monday, and continued at an evening session. The several papers presented and discussed covered the subjects thoroughly. Of special interest was the point that accident prevention should be regarded as an integral, not incidental, part of production,

and that management should determine the policy and develop the program. In plant equipment, it was explained that no design fits all foundries. Each foundry has its particular problems and equipment must be selected accordingly. A number of slides were shown to illustrate the subject.

The first session of the Annual Lecture Course dealt with magnesium and aluminum foundry control with the importance of synthetic sand, inspection and control instruments being stressed. It was pointed out that a daily inspection of magnesium casting equipment is necessary and should be done by a competent individual. An inspector's part in maintaining foundry control was not overlooked and it was noted that an inspector is, in some cases, a valuable asset.

Session 1 of the Gray Iron Shop Course sponsored by Gray Iron Division, Shop Operation Course Committee, dealt with the metallurgy of cupola mixes, a discussion of the factors determining metal quality in cupola melting. The keen interest of those attending this overflow session was evidenced by the general participation from the floor. Of particular concern was the quality of available fuel and the prospects of a return to prewar grades of coke.

Sponsored by the Sand Shop Operation Course Committee, the first Sand Shop Course session, a well-attended evening meeting emphasized the necessity of practicing sand control in all foundries, large or small. During the war, it was stated, surface finish was sacrificed for higher permeability to avoid blowholes, misruns and other defects resulting from excessive back pressure in the mold during pouring. Ideal sand properties were given as moisture, 1.5-2.5 per cent, green compression strength, 6-8 psi., permeability about 125, and over-all sand conditions for obtaining a good casting finish.

The question of the amount of work being done on centrifuge, precision casting or semi-centrifugal casting of magnesium parts arose at the evening meeting of the Aluminum and Magnesium Division. It was stated that some plants are making small centrifugal castings of magnesium.

Expected to become an annual affair, the first meeting of Engineering College Alumni was held on Tuesday, May 7, with 50 foundrymen representing 21 schools attending.

Stating that the meeting was a good beginning, Chairman F. G. Sefing outlined the objectives of the Committee on Cooperation with Engineering Schools. In the speeches which followed, engineering graduates agreed that the group should sponsor foundry educational activities in the schools represented. Those present believed that returning to talk to their former instructors would be effective advertising for the foundry industry.

Casting defects, primarily attributable to metal, were illustrated and discussed by W. B. McFerrin, in the second session of the Gray Iron Shop Course. Acting as chairman and discussion leader, he was assisted by George Anselman, who told the aims of the A.F.A. Committee on

Analysis of Castings Defects. It was explained that a book is expected to be published showing and describing casting defects. Later this is to be supplemented with details of foundry practice for eliminating defects.

Defects, illustrated clearly by slides, were described by the speaker and extensively discussed by the audience.

Tuesday morning and afternoon sessions on Malleable Foundry Practice, sponsored by the Malleable Division, offered a well-balanced program of papers to the many malleable men present. The subjects presented and discussed covered chemical composition of malleable iron, heat-treating furnaces, cores and core sand practices and control in foundries making various types of castings.

Aluminum and Magnesium Division's May 7 morning session was well attended. Many slides were used by the authors presenting the session's program papers. The principal points of discussion resolved about the effect of annealing upon as-cast structures in aluminum alloy castings, and the danger of gas absorption during heating of an aluminum sand-casting alloy to a temperature of 1700° F. It was suggested that the temperature, rather than the alloy additions, might be responsible for the tensile properties obtained.

The afternoon session on aluminum and magnesium reviewed the recent work of A.F.A. committees on the unsoundness encountered in cast light alloys and the dimensional stability of aluminum castings. It was reported that porosity in castings is due largely to gases in the molten metal, whereas shrinkage is due to inadequate feeding of the molten metal into the mold. It was also reported that warpage of aluminum castings is sometimes encountered during machining. The discussion brought out practical methods of dealing with stress relief heat treatments to minimize warpage.

The Inspection of Castings Committee arranged a full program for Tuesday, the second day of the meeting. The morning session consisted of presentation and discussion of program papers. In defining the function of an inspection department, it was brought out that its primary purpose is to safeguard the quality of the product manufactured. To function most effectively, it was stated, the inspection department should be directly responsible to top management.

A panel discussion made up the afternoon Inspection of Castings Session, at which buyers and suppliers of castings expressed opinions from their respective points of view, several discussors stating that adoption of standards of inspection and training of inspection personnel for proper application of standards would result in better evaluation of castings, distinguishing between de-

fects and irregularities and prevent the scrapping of many usable castings.

Afternoon and evening sessions, held on Tuesday, May 7, completed the Refractories program. Attendance at the sessions indicated wide interest in the subject. In the presentation and discussion of the several papers, it was brought out that refractories, to be heat resistant, must have a high fusion point, and that the pyrometric test cone, used to determine fusion temperature of refractories, should be incorporated into refractory purchase specifications.

The evening Refractory session included a practical step-by-step paper on how to line a cupola, and the "Question and Answer Panel." Many good questions were given to the panel members for study; a number of questions were answered on the spot from the floor.

Session 2 of the Lecture Course sponsored by the Annual Lecture Committee, with C. F. Joseph, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., acting as chairman, was a discussion of malleable foundry control. Mr. Joseph summarized his paper in a description of what he considered the best malleable control practices, from the raw materials as they come to the plant to the operational control of processes.

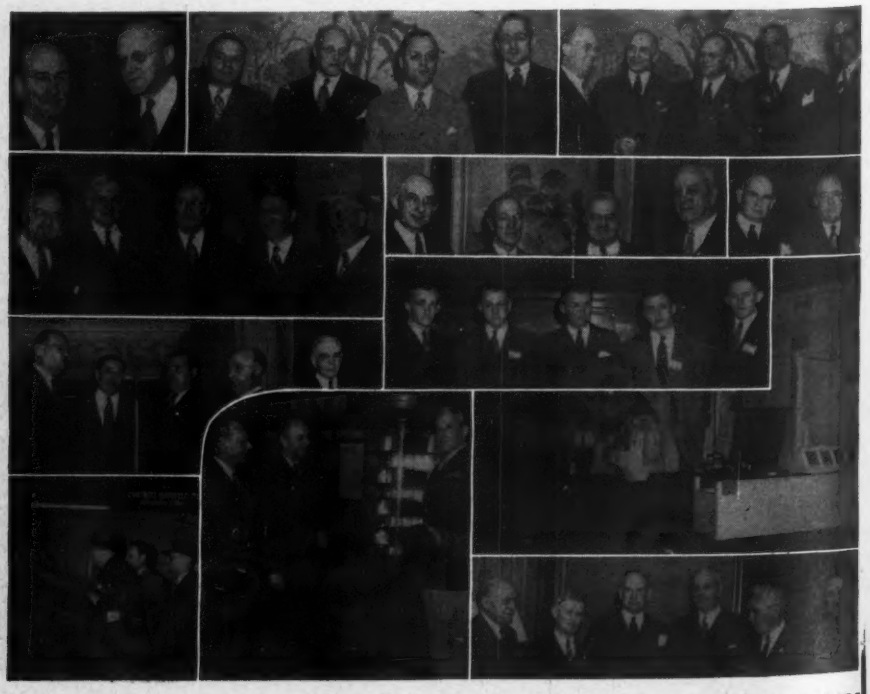
The Canadian Members' Luncheon was a general get-together for Canadian members of A.F.A., and past and present chairmen and vice-chairmen of the Eastern Canada and Newfoundland and Ontario chapters. On hand as guest was J. W. Pearce, British Cast Iron Research Association, Birmingham, England, who spoke to the membership.

Chapter officers and directors of the thirty-two A.F.A. chapters assembled in the Rose Room, Hotel Cleveland on Tuesday evening. To start the meeting each person introduced himself and gave his chapter affiliation. The jovial crowd enjoyed the extemporaneous remarks of the various speakers.

Session 2 of the Sand Shop Course sponsored by the Sand Shop Operation Course Committee was a discussion of sand control as practiced in a large mechanized malleable foundry and in a small non-mechanized foundry.

Core making practices in two large malleable foundries were capably discussed at the May 8 Malleable Foundry Practice session. In one plant, it was stated, a bank sand and three grades of washed and dried Ottawa sand were used.

Two well-attended meetings made up Brass and Bronze Division's program for May 8. At the morning session, papers on gas elimination, combustion conditions for crucible furnace melting, and fundamentals of fluid flow and experiments which showed the effect of smooth and



turbulent flow of molten metal on dross and other castings defects were presented and discussed.

Wednesday morning and afternoon sessions completed the Sand Research program sponsored by Foundry Sand Research Project, Technical Development Program of A.F.A. The interest in sand research is attested by the general participation in the discussions at these overtime sessions. The subjects presented and discussed included physical properties of foundry sands at elevated temperatures, heat absorption of sand, theory of molding sand binders, measurement of gases escaping from oil cores, fineness determinations and tests of molding sands, and prevention of veining and penetration on castings made in synthetically bonded sands.

A late addition to the afternoon program was the paper "Behavior of Molding Materials in Own Atmosphere at Elevated Temperatures," by H. W. Dietert and R. L. Doelman.

Engineering Symposium

The complete program of the Symposium on Engineering Properties of Gray Iron, sponsored by the Engineering Properties Committee, Gray Iron Division, was presented at morning and afternoon sessions on the third day of the meeting, May 8. The broad scope of the papers presented at these sessions, with the discussions, insures that their publication as a symposium will be a valuable contribution to the knowledge of the engineering properties of gray iron.

A technical discussion on the engineering properties of gray iron covered chemical and mechanical properties, structure, and wear resistance.

At the Malleable Round Table Luncheon held on May 8, A. M. Fulton acted as chairman in the absence of J. H. Lansing. Following a discussion of atmosphere controls for melting operations, Chairman Fulton introduced M. Remy, Belgium Foundry Technical Association, who presented to Dr. H. A. Schwartz a copy of a Belgian book on Malleable Iron. Reverting to the program, advantages and disadvantages of the double and single burner for melting, and the use of equalizers and dividers were discussed.

The Steel Session of May 8, sponsored by the Steel Division, presented the scheduled papers on bore cracks, homogenization heat treatment, thermal relief of stresses, and a report on heat treatment of steel castings. This group of papers was of a technical character. Much of the discussion centered around the homogenization heat treatment of cast steel.

At the May 8 session of Gray Iron Shop Course, the meeting chairman, W. A. Hambley, discussed the work of the A.F.A. Committee on Analysis of Castings Defects and mentioned that the work of the committee would be published monthly as a supplement to the AMERICAN FOUNDRYMAN. The supplements will be well illustrated and will fit into a standard loose-leaf notebook when completed. The talks dealt with defects due to the metal, such as open-grain structure (coarse grain) with large graphite flakes, misruns, inclusions, inverse chill, cold sheet, and kish.

At the May 8 Lecture Course Session, Co-chairman C. O. Thieme presided in the absence of H. M. St. John. Pointing out that foundry control methods vary among foundries because of differences in the 3,000 odd brass and bronze shops in the U.S., it was stated that good supervision is important in establishing and maintaining satisfactory foundry control.

Instructors' Dinner

The annual dinner for foundry instructors, sponsored by the Committee on Cooperation with Engineering Schools was held on May 8 and well attended by educators representing many schools, and representatives of industry and management. Presided over by Prof. P. E. Kyle, M. I. T., the meeting was addressed by A.F.A. Secretary Emeritus R. E. Kennedy, who talked on the early history of the foundry instructors dinner, pointing out that only four men were present at the first dinner.

The engineering student training technical session which followed the dinner was a panel discussion on college graduates and foundry management problems. In the discussion it was stated that many foundries seemed to be reluctant to accept college graduates, although there was a definite place for them. It was said that a college graduate with

broad engineering training should be able to learn to handle foundry work as readily as any other type of metal processing. Problems related to selection and indoctrination of engineering graduates and a presentation of the point of view of the recent college graduate employed in the foundry industry were followed by a 90-minute discussion in which many members of the audience participated, contributing their ideas and questioning the speakers at considerable length.

An evening session of Foreman Training, sponsored by the Committee on Foreman Training, was held on May 8. As in other years, the interest in this subject developed a general discussion. Opinions on various methods of training were expressed by the members present; for example, the question and answer method in training meetings rather than the showing of slides

Sand Shop Course Session No. 3, May 8, was conducted in conference style. Specific problems due to sand, such as veining, buckling, and scabbing were thoroughly and actively "mulled" over.

Two sessions on Foundry Costs, sponsored by Foundry Cost Committee, were held on May 9. The morning session was a panel discussion, committee members acting as discussion leaders. At the afternoon session, various factors entering into the establishment of cost prices of light and heavy castings were presented and discussed vigorously.

Before the fourth session of Gray Iron Shop Course, held May 9, an interested group of gray iron foundrymen heard a presentation on carbon control in the cupola. An open discussion on coke size developed, and the opinion was advanced that the mixing of large and small sizes of coke was undesirable, although perhaps unavoidable due to present supply conditions.

The Annual Business Meeting was held on May 9, A.F.A. President F. J. Walls presiding. Tom Makemson, Secretary, Institute of British Foundrymen and Official Representative of the British Ministry of Supply in charge of Cast Iron Production in Great Britain, conveyed congratulations of the I.B.F. to A.F.A. on the occasion of its 50th Annual Meeting.

President Walls addressed the meeting, reporting on the affairs of A.F.A. during the past year, announcing the success of the financial policy, the publications program, educational activities, staff plans for the National Office, the retirement of Jane Rienega and the illness of N. F. Hindle, from whom a congratulatory telegram was received and read to the meeting.

A.F.A. Secretary W. W. Maloney cast the single vote for the unanimous election of officers for the coming year, a list of whom will be found on page 22 of this issue.

Apprentice Contest winners whom, as a result of the early judging of entries, it was possible for the first time to bring to the meeting, received their awards from President Walls.

Dr. G. H. Clamer was introduced to the meeting and presented the A.F.A. Foundation Lecture entitled "Test Bars for 85 Copper—5 Tin—5 Lead—5 Zinc Alloy—Design and Some Factors Affecting Their Properties," and which will be published by A.F.A.

Steel Session

Steel sand practice, melting and molding practice were three subjects drawing considerable comment at the Steel Round Table Luncheon, sponsored by Steel Division. This session was held on May 9 at noon.

Papers presented at the Brass and Bronze Session, May 9, covered the use of insulating pads and riser sleeves, knock-off risers, and sealing bronze pressure castings through heat treatment. Discussion brought out that one material other than plaster could be used for insulating risers, but that the material was of less importance than the principle of the insulated riser. In discussing knock-off risers, it was shown that this method makes possible ready removal of risers, and that the tin coating on the riser screen is not essential.

Patternmaking session, May 9, sponsored by Patternmaking Division, presented papers on use of wood models in planning and design, and patterns as seen by the production foundry. The feature of the session was in the practical character of many questions brought up in discussion, and the no less practical answers.

At the Gray Iron session of May

9, an authoritative and informative discussion of the effect of cooling rate on microstructure, and mechanical and physical properties of gray iron was presented. The influence of graphite flake size and distribution on properties was illustrated by comparing a steel with a pearlitic iron of the same combined carbon content.

The importance of, and methods for, achieving cupola control were presented in a paper covering control tests, the production of inoculated irons for large castings, desulphurization with soda ash, and operation of balanced blast cupola. A good discussion followed.

In the absence of the author, the French exchange paper, "Technical Organization of the French Foundry" was presented in abstract form by R. Ronceray, president, Ph. Bonvillain and E. Ronceray, Choisy le Roi, France.

Wage Incentives

Two sessions on Job Evaluation and Time Study were held on May 9. At the first session, an informative paper on the part management should take in time study was presented. The subject covered wage incentives and proper rating and evaluation of jobs. The round table discussion in the evening permitted those attending to obtain answers to general questions on this subject, such as the selling of new standards on an old job, how to train a time study man, and whether time study men make good supervisors.

A full program arranged by the Apprentice Training Committee for May 9 included an afternoon panel discussion, a dinner, and an evening session. Panel discussion speakers, emphasized the value of retaining the training methods developed during the war despite the many problems encountered. At the dinner and session which followed, it was pointed out that changes in training procedures were required as foundry practice advanced from year to year, and that apprentice training, as contrasted with shorter, less complete types of instruction programs, is much the more valuable.

Session 4 of the Lecture Course sponsored by the Annual Lecture Committee was held on May 9. The speaker covered his subject, steel foundry control, rather thoroughly, particularly emphasizing the use of a laboratory in a modern steel plant. Steel melting practices and control factors were topics of discussion by those attending the session.

Core Sand

Session 4 of the Sand Shop Course sponsored by the Sand Shop Operation Course Committee was an evening session on May 9. A paper on factors for consideration in purchasing core sand was presented. The general discussion dealt with defects caused by sand expansion, sand flowability and the effects of sand mixing and tempering on flowability.

In the absence of the chairman, J. S. Vanick presided at the fifth Lecture Course Session on May 10. The discussion of gray iron foundry control was approached from the angle of the small foundry. It was said that foundries which felt that they had no need for control would find that they were already using some control procedures. The speaker translated scrap losses into financial losses as an argument in favor of control, stating that any foundry needs control, and that the need would be greater five years hence.

The discussion leader used charts and samples in conducting the fifth session of the Sand Shop Course, a morning meeting on May 10. The discussion dealt with molding materials (sands and binders) and core making control conditions as applied in a steel foundry. The use of dyes for core sand identification was also discussed.

The final Gray Iron Session on May 10 presented papers on the effect of heat treatment on endurance limits of alloyed gray cast irons, engineering properties of heat treated cast irons, and theories of gray cast iron inoculation. A number of slides were shown to illustrate a discussion on the practical use of charts and tables in the CUPOLA OPERATIONS HANDBOOK.

Hardenability

At the morning Steel Session of May 10, papers on hardenability requirements in steel foundries, quality control methods, and methods of risering steel castings were presented. In the discussion it was suggested that the belief that equal hardenability will give equal properties is not always true, and that the hardenability test can not be used alone as a criterion of properties.

The afternoon Steel Session of May 10 included papers on low temperature properties of steels, the I.B.F. Exchange Paper on production of bomb castings, and the report on non-destructive testing.

Papers presented at the Gray Iron Welding Session of May 10, sponsored by Gray Iron Division, included the metallurgical aspects of cast iron repair welding, physical aspects of welding gray iron castings, and welding heavy iron sections.

At the May 10 Brass and Bronze session, a committee report on work done by the A.F.A. Ordnance Committee at the request of the U.S. Army Ordnance Dept., Frankford Arsenal, on problems peculiar to manganese-bronze alloys was presented.

Annual Dinner

Marking the close of the five-day Golden Anniversary Meeting of the American Foundrymen's Association, Toastmaster Fred J. Walls, President of A.F.A., welcomed the guests at the Annual Dinner.

Following the dinner, Past-President Ralph J. Teetor presided at the presentation of awards and life memberships in A.F.A., Hyman Bornstein receiving the Wm. H. McFadden Gold Medal, Howard F. Taylor the Peter L. Simpson Memorial Medal, and Peter Blackwood the John H. Whiting Gold Medal. Wm. J. Coane and Harold J. Roast received life memberships in A.F.A.

Addressing the meeting on "The Foundry in War and Peace," Brig. General Donald Armstrong, Army Industrial College, Washington, D. C., warned that the outbreak of war in the atomic age probably would not allow time to make up for lack of preparation in times of peace. "I am convinced," said Gen. Armstrong, "that the technological developments in foundry practice were more radical and more effective than in almost any other industry during World War II. The fantastic weight of castings for armor, centrifugally-cast guns and many previously unknown applications of the foundrymen's art demonstrate to what extent the foundries contributed to victory."

Officers and Directors

(Continued from Page 23)

neering Society of Detroit. In 1930 he was chosen to present the A.F.A. exchange paper to the Institute of British Foundrymen.

H. G. Lamker

H. G. LAMKER, foundry superintendent, Wright Aeronautical Corp., Patterson, N. J., elected a National Director, American Foundrymen's Association, has been connected with the aluminum foundry industry continuously for nearly 30 years. He is the first representative of the Aluminum and Magnesium Division elected A.F.A. Director.

Born in Pittsburgh, Pa., Mr. Lamker graduated from Carnegie Institute of Technology, Pittsburgh, with a metallurgical engineering degree. He spent four years with the General Electric Co. performing experimental work; two years with the Johnson Bronze Co. as metallurgist and foundry superintendent, and four years with Aluminum Castings Co. (later Aluminum Co. of America) as assistant technical advisor. Mr. Lamker assumed his present position in 1922.

B. L. Simpson

BRUCE L. SIMPSON, elected a National Director of the American Foundrymen's Association, is president, National Engineering Co., Chicago. Mr. Simpson has recently addressed a number of A.F.A. chapters on the history of the castings industry, and represents the foundry equipment industry on the Board.

Mr. Simpson was born in Chicago and attended Hobart College, Geneva, N. Y., and Northwestern University, Evanston, Ill. He obtained his Bachelor of Science degree in 1934 from the latter university. Two years later, 1936, he received an LL.B. degree from the Northwestern Law School. Admitted to the bar in April, 1937, he severed his legal connections to become purchasing agent with the National Engineering Co. After serving several years in that capacity, he was made vice-president in charge of operations and, in 1942, became president.

Mr. Simpson has held several positions of importance in various technical and trade associations. He is a director of the Foundry Equipment Manufacturers Association, and has held the position of Director, Secretary and Treasurer of the Chicago chapter of the American Foundrymen's Association.

He is the author of the book "HISTORY OF THE CASTINGS INDUSTRY," now in process of publication by the American Foundrymen's Association. Along with his A.F.A. activities, Mr. Simpson also is a member of American Chemical Society.

H. A. Deane

HORACE A. DEANE, as vice-president in charge of operations, American Brake Shoe Co., Brake Shoe & Castings Division, New York, has been elected a National Director of A.F.A. as a gray iron representative to the Board of Directors. Over a period of years he has served on many committees of the Gray Iron Division, has been a well-known speaker before chapter, regional and national meetings of A.F.A., and has been especially interested in practical phases of sand control and cupola operation.

Mr. Deane was born in Bloomington, Ill. In 1926 he obtained his Bachelor of Science degree in chemistry from the University of Illinois, Urbana, Ill. Resuming his affiliation with Deere and Co. laboratories, Moline, Ill., in which he had worked before attending the University of Illinois, he was made foundry metallurgist. He remained with Deere and Co. until 1939 when he joined the Brake Shoe & Castings Division, American Brake Shoe Co., to become assistant works manager. Appointed works manager in 1943, he assumed his present position with the company three years later, having supervision of eighteen plants.

He served as Chairman of the A.F.A. Quad-City chapter during his affiliation with Deere and Co., and at present is Chairman of the A.F.A. Metropolitan chapter. A member of A.F.A., he also holds membership in ASM and is a past Chairman, ASM Tri-City chapter.

S. C. Wasson

STOWELL C. WASSON, manager, National Malleable & Steel Castings Co., Chicago and Melrose Park, Ill., works, was elected Director of A.F.A. at the 50th Anniversary Convention in Cleveland. One of the organizers of the Central Indiana chapter, he is particularly interested in the training of young technicians and engineers.

Mr. Wasson was born in Indianapolis, and became affiliated with National Malleable & Steel Castings Co. after graduating from high school. His first job was as clerk in the purchasing department of that company. At every opportunity, he studied metallurgy and plant processes, and eventually worked at practically every job in the plant. After 19 months military service in World War I, upon his return to the company he became a member of the sales department. He was later named sales manager and in 1929 became manager of the Indianapolis plant. In 1943, he was appointed manager of the Melrose Park and Chicago plants.

J. E. Kolb

J. E. KOLB, superintendent, pattern shop, Caterpillar Tractor Co., Peoria, Ill., represents the Patternmaking Division on the Board of Directors and is the first director elected from the Central Illinois chapter.

Born in Lewistown, Ill., in 1887, he received his early education there and later attended Bradley Polytechnic Institute, Peoria, Ill. Jim Kolb served four years as an apprentice in patternmaking with the former Parlin and Orendorff Co., Canton, Ill., now a branch of the International Harvester Co. In 1907, he took a position as patternmaker with the Avery Farm Machinery Co., Peoria, where he served four years. Successively thereafter he was connected with the Kingman Plow Co., Peoria, the former Hart Grain Weigher Co., Peoria (now Hart Carter Co.), and from there became employed at the former Holt Mfg. Co., which became the nucleus for the organization now known as the Caterpillar Tractor Co.

Beginning as a patternmaker, he worked on the bench for one year, then was made foreman of the pattern shop. Today, while his official title at Caterpillar is superintendent of the pattern shop, his duties include responsibility for the design and manufacture of both wood and metal patterns, the foundry machine shop, the wire room and pattern storage, all of which are under his supervision. At present he has been connected with Caterpillar for over 30 years.

Director Kolb has held membership in A.F.A. for a number of years and has presented a number of papers and talks at Regional Conferences, Lecture Courses and Annual Meetings of the Association.

COMMITTEE MEMBERS
Needed for Association Activities

ANYONE INTERESTED in playing a broader part in A.F.A. activities should consider serving on one of the association's 115 committees. Aiding the entire membership and providing information of value to the whole foundry industry, the 800 members of these committees exemplify the spirit of cooperation which has existed since A.F.A. was formed.

Apply Now

Although applications for places on committees are accepted at any time, those interested are urged to consider serving now. As the end of a year of intensive committee activity approaches, revision of committee personnel is being studied. Committee members unable to continue their work must be replaced. New trends in work require the addition of committee members qualified to aid in revised committee objectives.

Committees covering every phase of foundry practice and of interest to everyone in the foundry industry provide an opportunity for all to participate. Consisting primarily of six divisions and a number of general interest committees, the A.F.A. committee structure also includes representatives on committees of other societies and and cooperative projects. The six A.F.A. divisions are: gray iron, steel, malleable, brass and bronze, aluminum and magnesium, and patternmaking.

Qualifications

Each division consists of a number of committees devoted to the consideration of problems peculiar to the family of alloys cast. Committee members may be superintendents, metallurgists, molders, management representatives, educators, or anyone interested and able to contribute to the work of the group. Division committees include those responsible for the annual convention program, a number devoted to methods and practices, specifications, microstructures, and other interesting and important topics.

General interest committees include those for apprentice training, cooperation with engineering schools, foundry costs, castings inspection, and others related to foundry methods and practices. Committees have long been active on special research projects studying foundry sands and cores, heat transfer, and fluidity testing. Work of the A.F.A. committees on safety and hygiene is recognized nationally and used as a basis for industrial hygiene codes.

A.F.A. committee work is carried on by correspondence and by meetings held as frequently as travel conditions allow. Reports are prepared periodically and are printed in AMERICAN FOUNDRYMAN or presented at the annual A.F.A. convention. Valuable publications have resulted from the work of many of the committees. The CUPOLA HANDBOOK, available now, was prepared through the cooperation of 12 committees and several hundred committee members. Other publications written and under constant revision by committee workers are CAST METALS HANDBOOK, SAND TESTING HANDBOOK, ALLOY IRONS HANDBOOK and RECOMMENDED PRACTICES FOR NON-FERROUS ALLOYS. The Committee on Analysis of Casting Defects is planning a book on defects in gray iron castings.

Rewards of Service

Personal satisfaction of serving the foundry industry, stimulating contact with fellow foundry workers, and ideas for solution of local foundry problems are some of the reasons given by committee workers for active participation in A.F.A. committee affairs.

Open to members or non-members, committee membership may be arranged through the National Office or through division chairmen. Write to American Foundrymen's Association, 222 West Adams St., Chicago 6, or to the following division chairmen: *Gray Iron Division,* T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.; *Steel Division,* C. H. Lorig, Battelle Memorial Institute, 505 King Ave., Columbus, Ohio; *Malleable Division,* A. M. Fulton, Northern Malleable Iron Co., 867 Forest St., St. Paul, Minnesota; *Brass and Bronze Division,* D. Frank O'Connor, American Saw Mill Machine Co., Hackettstown, N. J.; *Aluminum and Magnesium Division,* R. E. Ward, Eclipse Pioneer Div., Bendix Aviation Corp, Bendix, N. J., and *Patternmaking Division,* Frank C. Cech, Cleveland Trade School, 535 Eagle Avenue, Cleveland, Ohio.

Applications for committee membership should include mention of specific foundry interests as well as the names of committees (if known) on which membership is desired.

Judges Named For Apprentice Contest

JUDGES FOR the 1946 A.F.A. National Apprentice Contest recently were announced by George A. Zabel, Universal Foundry Co., Oshkosh, Wis., chairman of the A.F.A. Apprentice Contest Committee.

Secured through the cooperation of J. G. Goldie, Head, Foundry Division, and Frank C. Cech, Head, Patternmaking Division, Cleveland Trade School, Cleveland, both members of the Apprentice Contest Committee, the judges were selected from the Cleveland area to minimize travel difficulties.

Meeting April 27 at the Cleveland Trade School, the judges selected the three best entries in the four divisions of the contest.

Consultant and chairman of judges for the molding divisions was Pat Dwyer, *The Foundry,* who also aided in judging the pattern division entries. Judging the gray iron molding division were: Grover C. Cole, Forest City Foundries Co.; Frank Weisehan, Ferro Machine and Foundry Co., and Milo Barrett, Chandler and Price Co., all of Cleveland.

The steel molding entries were judged by: Tom West, West Steel Castings Co.; Louis Klein, Crucible Steel Castings Co., and E. C. Zirzow, National Malleable and Steel Castings Co., all of Cleveland.

Judges for the non-ferrous molding division were: Dan Gluntz, Gluntz Brass Foundry; Edward J. Metzger, Wellman Bronze & Aluminum Co., and Fred J. Fredriksen, Westinghouse Electric Corp., all of Cleveland.

The following were judges for the patternmaking division: Walter Seebeck, Western Pattern Works; Tom Gallagher, Cleveland Punch & Shear Works; V. J. Sedlon, Master Pattern Co.; George Gedeon, Aluminum Company of America; Edward Pierie, Motor Patterns Co.; Pete Rettig, Rettig Pattern Co.; Carl

Hamburger, Cleveland Board of Education; Ray Tisdale, Service Pattern Works; Frank Hrabak, East End Pattern Works; James Young, Standard Pattern Works, and George Gibala, Royal Pattern Works.

Handbook of Cupola Operation Ready

ANOTHER NEW publication released by the Technical Development Program of the American Foundrymen's Association is the "HANDBOOK OF CUPOLA OPERATION." This 468-page cloth bound book is a complete, up-to-date, accurate and authoritative reference book dealing exclusively with the various phases of cupola operation known to the profession.

Conceived June 1939, it represents the results of the "Cupola Research Project," comprising the technical contributions of 1282 authors, the best talent in the industry, and supported financially by 236 companies

Comprehensive scope of the book is evidenced by just some of its highlights — Operation of the Cupola, the Refractory Lining, Blowing Equipment, and Blast Control Equipment, Forehearth and Receiving Ladles, Blast Conditioning, Classification of Scrap for Cupola Mixtures, Foundry Coke, Cupola Slags, Fluxes and Fluxing, and Fundamental Thermochemical Principles.

Contained in its pages are 188 graphs and illustrations, and 34 tables giving evidence of its broad and complete contents. In addition, it contains an extensive classified list of references to earlier works on this important subject. In Appendix I will be found a complete tabulation of suggested analyses of cast iron classed both as to strength and specific application. In brief, it is a book no foundry library or cupola operator can be without.

Copies of the HANDBOOK OF CUPOLA OPERATIONS were on display and available for inspection at the A.F.A. Publications Booth at the 50th Anniversary Foundry Congress. A copy of the book may be secured by direct application to the headquarters of the American Foundrymen's Association, 222 W. Adams St., Chicago, Ill. Orders are being accepted at the member price of $4.50 per copy and to non-members $5.50.

APPRENTICE CONTEST
Winners Announced at Cleveland

WINNERS of the 1946 A.F.A. National Appentice Contest were selected April 27 by judges meeting at the Cleveland Trade School, Cleveland. Judges are named elsewhere in this issue.

Cash prizes of $30, $20 and $10 and certificates have been awarded to the first, second and third place winners in each division of the contest. In addition to the usual awards, the first prize winner of each division came to Cleveland to receive his award at the Annual Meeting and to participate in convention apprentice training sessions.

Successful Contestants

Winners of the 23rd annual contest are as follows:

Gray Iron Molding Division

First prize: Lawrence Kinsinger, Caterpillar Tractor Co., Peoria, Ill.

Second prize: M. Tamburini, Warden King Ltd., Montreal, Que.

Third prize: Harold Young, Cleveland Trade School, Cleveland.

Steel Molding Division

First prize: Robert Bina, Crucible Steel Casting Co., Cleveland.

Second prize: John Pietrzyki, Crucible Steel Casting Co., Cleveland.

Third prize: John Kraynak, West Steel Casting Co., Cleveland.

Non-ferrous Molding Division

First prize: C. Corriveau, Montreal Technical School, Montreal, Que.

Second prize: P. Blais, Montreal Technical School, Montreal, Que.

Third prize: H. Deschamps, Jenkins Bros., Montreal, Que.

Patternmaking Division

First prize: R. Dragon, Western Pattern Works, Montreal, Que.

Second prize: John Yeich, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Third prize: Michael Simenic, Aluminum Co. of America, Cleveland.

Veterans Return

Two of the winners illustrate the continued interest in the contest shown by many apprentices and the desire to come back into the foundry industry after completing a period of service with the armed forces. Lawrence Kinsinger, winner this year in the gray iron molding division, also won first prize in the 1943 contest. Robert Bina has taken first place in steel molding in 1946, 1942 and 1941.

Sponsored annually by the Apprentice Training Committee since 1924, the contest always arouses widespread interest among foundrymen. According to the committee chairman C. W. Wade, Caterpillar Tractor Co., Peoria, Ill., the apprentice contest has aroused greater enthusiasm for good workmanship and good foundry practice in the participating shops. Management is stimulated to improve training activities and facilities by entrance of apprentices in the annual competition. The general public has become more interested in the foundries in which contest entrants work. Apprentices and foundry workers take greater pride in their foundry because they feel they are part of a progressive organization which is backing the foundry industry and the American Foundrymen's Association.

Oxy-Acetylene Cutting Facilitates Cleanup

PRODUCTION CASTING OUTPUT in the foundry can be increased materially through use of oxy-acetylene cutting techniques in removal of risers and gates, P. A. Spaulding, Linde Air Products Co., New York, reports in a recent issue of *Materials & Methods.*

Procedure Flexible

Templet-guided repetitive setups for contour cutting permit continuous, semi-automatic removal of surplus metal, and minimize required grinding per casting. Castings are clamped in jigs and necessary cuts are made in continuous, automatic cycles; templets (which are standard and made of aluminum strip) and jigs vary with the job.

In one case described, cutting speed of 10 in. per min. through 3 in. of steel was obtained; and with a dual setup, gates were removed from cast steel fittings and the fittings separated at a production rate of 224 per day.

MALLEABLE CORE MAKING PRACTICE

In the mechanized foundry of today, the sand used in the coreroom is the basis for the sand in the foundry. Proper selection of sands for cores is of utmost importance as these sands will largely determine the casting finish obtained and permeabilities of foundry sands.

E. C. Zirzow
National Malleable & Steel Castings Co.
Cleveland

CONTROL OF CORE SANDS has been neglected by the foundry industry as a whole. Great strides have been made in the proper control of foundry sands, but little has been done with core sands and mixtures, and it is the author's intention to present a brief summary of general coreroom practice in the malleable foundry with which he is associated.

Sands are received in the plant in open hopper cars. These sands are unloaded and placed in the various bins in the storage bay. From the bins the sands are taken by means of a grab bucket and crane to the sand dryer. At the dryer the moisture is reduced to about 0.3 per cent and sand conveyed by means of an elevator and belts to the storage hoppers in the mixing room.

Sand Buggy

Sands are drawn from these bins through hand-operated gates and placed in a buggy which holds 800 lb. of sand. The sand buggy is pushed by hand to the electrical hoist at the sand mixers. At this point the sand and buggy are hoisted above the sand mixers and the sand flows into the mixer. The buggy is lowered and is ready for the next batch.

Clay and cereal binder are received in box cars and transported by truck to the storage room in the basement. From storage it is conveyed by hand truck to the mixing room. The mixer operator then dumps the bags into bins located at the two mixing machines.

Core oil is blended in the core oil plant in the foundry and pumped into large storage tanks for aging. From these aging tanks the core oil is pumped to smaller tanks in the mixing room.

After the sand has been placed in the mixer as described, the green bonding material is added. These binders are measured and added by volume. This mixture of sand and green binder is mixed for one min. Core oil is then added, followed immediately by the water, and mixed an additional 4 min.

Core Sand Distribution

The core sand mixture is discharged from the mixer and conveyed by elevator to the distribution bins located in the mezzanine floor above the coremakers. From these distribution bins the mixture is taken by cart or buggy and dumped into the hoppers of the coremakers.

Coremakers are grouped about four vertical-type continuous ovens (Figs. 1 and 2). About 90 per cent of the work is made on core blowing machines, the remainder being bench and roll-over. After the cores have been made they are placed directly in the oven by the coremaker. The cores are unloaded on the opposite side of the oven, placed on gravity roller conveyors and permitted to cool (Fig. 3).

After cooling the cores are finned, gauged and mudded and placed in boxes. These boxes of cores are transported by buggy to the various molders' stations as needed. The coreroom endeavors to keep a 4-hr. supply of cores ahead of the foundry.

All sands as received are practically clay free. These sands can be divided into three classifications, coarse, medium and fine. A fourth sand is used for special work requiring a high permeability. Typical screen analyses of the four sands are listed in Table 1.

Medium-grained sand is the basis sand and is the sand upon which the entire sand control in the foundry is based. From this sand the majority of the cores is made. If it is necessary to obtain more permeability, either in the core or the foundry sand, coarse sand is blended with this medium-grained sand. To decrease the permeability it is the practice to blend in the fine-grained sand. Every effort is made to do this blending in the cores in order to save additions of the coarser- or finer-grained sands in the foundry.

Defective Cores

In most cases, this is the most economical procedure. However, there are exceptions. If it is found that with additions of the finer- or coarser-grained sands defective castings are produced due to defective cores or, in other words, the core has not met the required specifications, then the core sand is changed so that the core will do the job required of it in the foundry.

Sand grains of the three regular sands are of sub-angular shape. The special sand is composed of sub-rounded grains. All four sands have minimum fusion points of 2850° F.

This paper was presented at a Malleable Foundry Practice Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 8, 1946.

Fig. 1—View showing coremaking machines grouped about the core ovens.

and go as high as 3100° F. maximum.

With the exception of the fine sand, these sands withstand thermal and mechanical shock. The slight breakdown of the grains due to these shocks is well above the permissible amount.

All sands are subjected to screen analysis before unloading. Tolerances are set up, and the sands must come within these tolerances or they are rejected.

For the development of green bond in the core sands, corn cereal and bentonite are used. The cereal is tested on a weight per volume basis and must meet the specifications. The bentonite is tested in the foundry and must meet the foundry specifications.

Core oil consists of a blend of a vegetable drying oil, rosin and kerosene. These ingredients are blended with heat and aged in storage tanks.

At the present time paddle-type mixers of an ancient design are used. These mixers first mix the sand and green binders, which are in the dry state. The sand grains then are coated with the oil and, finally, the water develops a paste from the green binders. The coating of the grain with the oil and the development of the green bond are accomplished simultaneously.

Various mixtures of the sands, green binders and core oils are used to produce cores with various physical properties. These physical properties are varied to meet specific foundry conditions. Specific examples of these mixtures are listed in the following paragraphs.

Mixture No. 1 is used for cores requiring maximum permeability, or cores which, because of design, it is impossible to vent by mechanical means. The scratch hardness of these cores will run between 55 and 65.

Mixture No. 2 is used for cores requiring high permeability and slightly higher green and baked strengths. The scratch hardness of the cores made from this mixture will run between 60 and 70.

Mixture No. 3 is used for cores which require an exceptionally rapid collapsibility. Baked scratch hardness of these cores will run between 60 and 70.

Mixture No. 4 is perhaps the most widely used of all the mixtures. This mixture must be sufficiently open to permit ready escape of the gas, and have sufficient strength in the baked condition to prevent cutting by the metal. Green strength must be sufficiently high to prevent distortion on the form dryer. Baked scratch hardness of these cores will run from 70 to 80.

Mixture No. 5 is used for cores requiring a high green strength. These cores usually are made without the aid of form dryers. Baked scratch hardness will run between 60 and 70.

Mixture No. 6 is a hard sand and is used for ram-up, gate cores, and on all cores which must withstand abuse in the molding operation. Cores of this mixture will have a baked hardness of 80 to 90.

All cores are baked in vertical-type continuous ovens. These ovens are equipped with a variable speed control so that the baking cycle may be varied as the need arises. The burners are designed so that either natural gas or fuel oil may be used. Natural gas is the usual fuel.

Temperature may be varied and is controlled by means of a gas-filled

TABLE NO. 1

RETAINED ON	COARSE	MEDIUM	FINE	SPECIAL
12	0.00	0.00	0.00	0.00
20	9.30	2.20	0.15	0.00
30	20.65	2.80	0.50	1.30
40	28.95	6.35	1.50	59.25
50	23.00	23.00	4.50	36.35
70	10.20	40.00	16.00	3.10
100	6.00	20.70	41.50	0.00
140	1.70	4.10	21.05	0.00
200	0.10	0.60	7.70	0.00
270	0.05	0.20	2.45	0.00
PAN	0.05	0.05	4.65	0.00

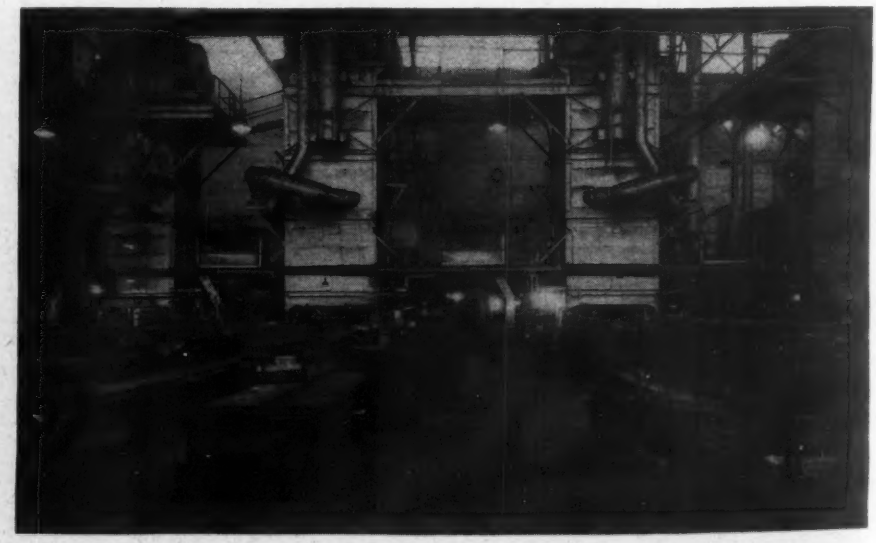


Fig. 2—Battery of vertical-type continuous core ovens.

Fig. 3—Photograph of operation at core oven unloading station.

tube extending through the oven at approximately the hottest point. A portion of the gases and products of combustion are recirculated through the oven by means of a recirculating blower. Natural draft is used to exhaust the moisture and volatile combustible matters formed in the baking operation through a series of adjustable flues on each oven.

Load-to-unload cycle will vary from 60 to 70 min. Graphs (Figs. 4, 5, 6 and 7) show the results of running a traveling thermocouple through the four ovens. Temperatures were read for every foot of travel.

On oven No. 1 the moisture evaporation point is reached in about 10 min. and 20 sec. Baking temperatures are reached in 17 min. and 34 sec. Actual time in the baking temperatures is 39 min. and 16 sec. This leaves a cooling zone of 9 min. and 18 sec.

Moisture evaporation point on oven No. 2 is reached in 9 min. and 18 sec. Baking temperatures are reached in 15 min. and 30 sec., and the temperature remains above the baking level for 38 min. and 14 sec. Cooling zone is the last 12 ft. of travel, or 12 min. and 24 sec.

Oven No. 3 reaches the moisture evaporation point in 11 min., the baking temperature about 30 sec. later. The cores remain in the baking zone for 40 min. and 30 sec. and are then cooled in the last 12 ft., or 12 min. of travel.

The graph (Fig. 7) for oven No. 4 shows that the moisture evaporation point is reached in 13 min. and 52 sec. Baking temperatures are reached in 18 min. and 8 sec., and the cores remain at or above the baking temperature for 38 min. and 12 sec. The remaining 11 ft. or 11 min. and 44 sec. comprise the cooling zone.

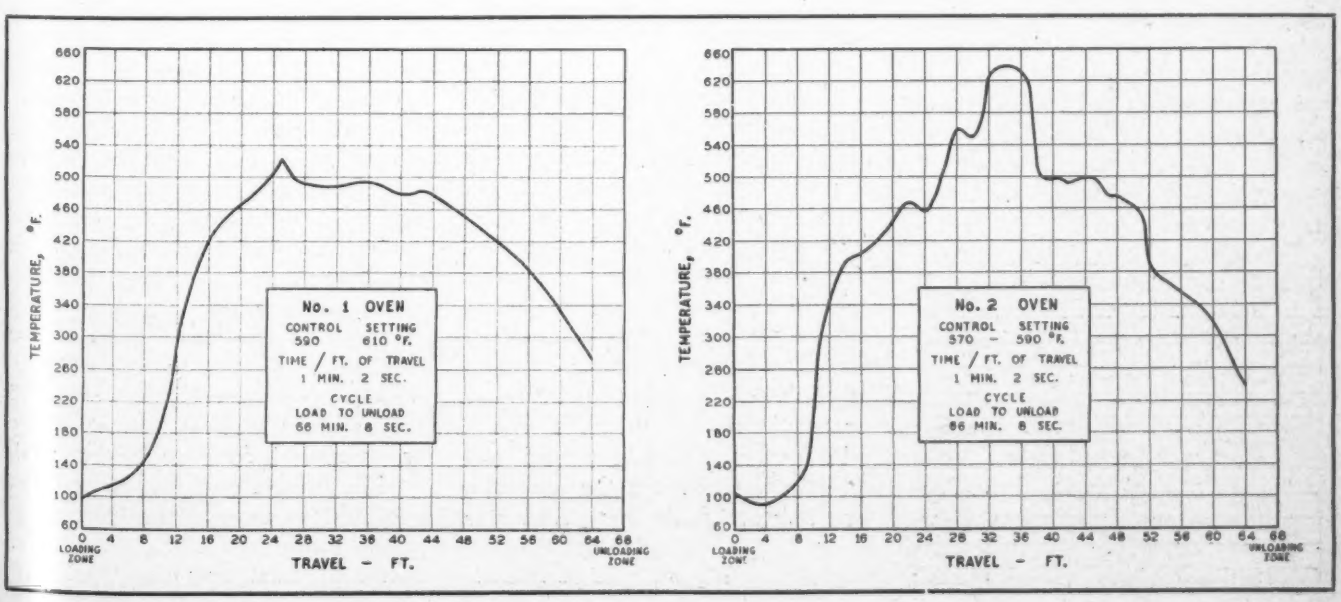
Temperatures mentioned in the foregoing are oven temperatures and not core temperatures. No doubt, the outside of the core will reach the temperatures shown in approximately the final 15 ft. of travel, but it is with considerable difficulty that temperatures much above 212° F. are attained in the core centers, especially in large cores. At present, this plant is in the course of determining the temperatures reached in the center of various sizes of cores, using the oven temperatures and cycles given in the foregoing.

A relation between the temperature control setting and the actual temperatures attained in the oven is not apparent. This may be due to the gas tube not being located in the proper place in the oven, or to the gas tube going out of calibration.

Gas-Filled Tube

It is possible that the traveling thermocouple may not be giving as good an average as the gas-filled tube which actuates the burner. However, the great variation in the control settings of the various ovens would indicate that the fault lies with the gas-filled tubes. Regardless of what the temperature control setting may be, the final criterion

Fig. 4 (left)—Chart showing temperatures through a cycle of No. 1 core oven. Fig. 5 (right)—Temperatures through a cycle of No. 2 core oven.



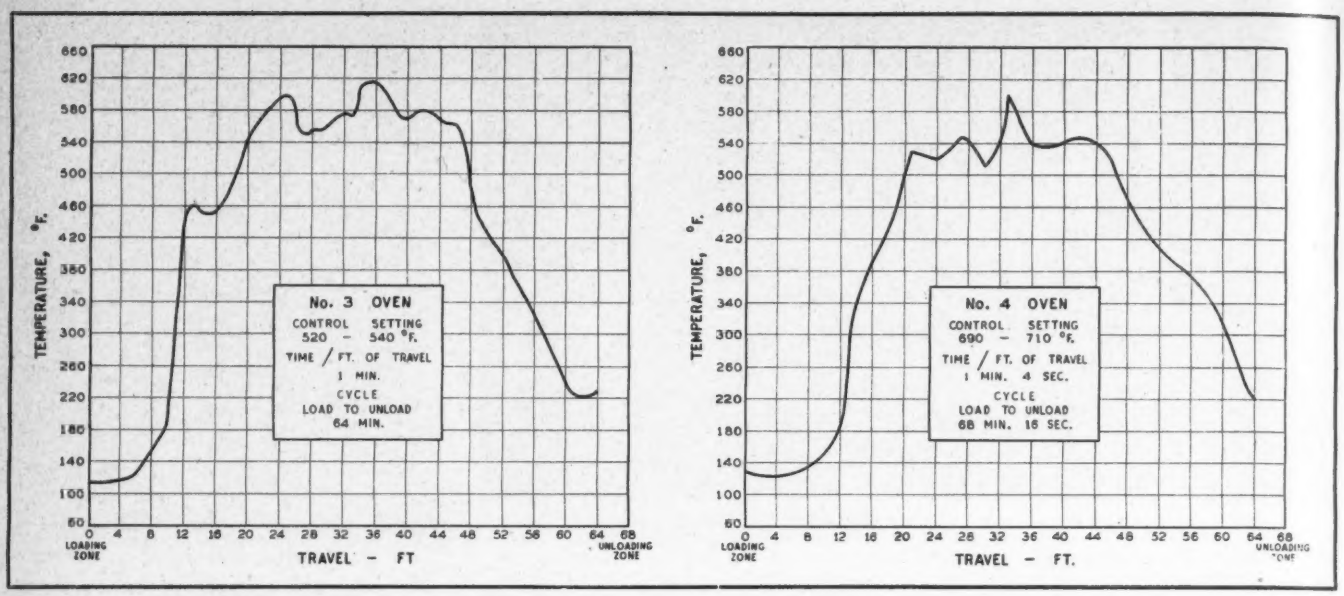


Fig. 6 (left)—Temperatures through a cycle of No. 3 core oven. Fig. 7 (right)—Temperatures through a cycle of No. 4 core oven.

should be the actual results obtained on the cores.

While on the subject of core ovens and core baking, it may be advisable at this time to review briefly the mechanics or steps involved in the process of baking cores.

Binders may be roughly divided into four classes: (1) those becoming solid or firm upon freezing; (2) becoming firm at room temperature; (3) becoming firm upon heating; (4) clays. In other words, cores requiring a subnormal temperature, cores requiring room temperature, cores requiring heat and, of course, clays in a class by themselves.

Malleable Cores

As a whole, the malleable industry does not use cores requiring a subnormal temperature or room temperature to become solid. However, use is made of binders which become firm upon heating, and of clays. The binders which find the greatest application in the making of malleable cores are those which become firm upon heating.

This class can be further subdivided into the binders that occur in the solid state, such as pitch and rosin, and which, upon the application of heat, become a viscous liquid which surrounds the sand grain. Upon cooling this mixture of sand and binder resumes its original state and forms a solid mass of the required shape.

The second subdivision includes the cereals, sulphites and proteins, and may be classified as adhesives. Adhesives, upon the introduction of water, become gelatinous and produce the green strength in the mixture. Upon application of heat these binders are dehydrated and become hard, thus holding the sand grains together.

A third subdivision is that of the core oils, which group includes the vegetable oils, wood oils, fish oils and the polymers, either vegetable or mineral. In the formation of the baked strength of this group are five distinct steps. It is true that some of these steps may overlap each other, but they do occur and must occur for proper baking of a core containing these ingredients.

1. Evaporation of moisture.
2. Evaporation of volatiles.
3. Oxidation.
4. Polymerization.
5. Decomposition.

Moisture evaporation is the first step and requires the greatest amount of time. The core temperature will not rise above 212° F. until all water has been evaporated. Silica sand is a notoriously poor conductor of heat, and temperature must be attained through the entire body of the core for proper baking. The most common defect in cores baked in continuous ovens is that of green center.

The core surface is heated sufficiently to drive out the moisture, but ample time is not allowed to bring the center of the core to the temperature necessary to permit the evaporation of moisture to proceed. However, temperature alone is not the only method available for evaporation of moisture. Evaporation depends upon the changes of air. It is much easier to dry clothes on a windy day than upon a day of little or no breeze. In the drying of clothes temperatures of 212° F. are not used but, nevertheless, the clothes do dry.

Moisture Evaporation

Hence, in the evaporation of moisture from cores it is necessary to have (1) a movement of dry air through the oven and (2) to avoid saturation of the air, a sufficient temperature. It is a known fact that it is harder to bake cores on a humid day, when the air is saturated with moisture, than upon a day when the air is dry.

In the graphs (Figs. 4, 5, 6 and 7) showing the temperature and cycles of the various ovens, about 50 per cent of the total time the temperatures of the ovens are at or above the baking temperature, or about 35 to 40 min. This is ample time to permit of evaporation of the volatiles, and for the oxidation and polymerization to proceed provided that the moisture has been removed. Evaporation of the volatiles proceeds along with the evaporation of the moisture. The oxidation will proceed as soon as the oil has been freed of moisture and the oxygen in the air can have free access to the oil.

The principle of evaporation can be used to prevent the decomposition or burning of thin sections of cores by saturating these thin sec-

tions with moisture, and is a common practice.

Use of clay as a binder in cores is quite common. Various green cores are made of molding sands, and not only rammed but blown.

Cores in the malleable foundry are made on the bench, with a blow machine, and with a jolt or roll-over machine (Fig. 8). Cores may be either hand rammed or rammed with a pneumatic hammer. To the best of the author's knowledge, malleable cores are not made with a sand slinger.

The method used in making cores will depend upon:

1. The number of cores required.
2. The available equipment.
3. The form or shape of the core.

Generally speaking, if only a small number of cores are required on the order, from a cost standpoint it would not be economical to prepare a blow plate and vent the core box. In other cases, the cores could be made in the time required to set up the machine.

Make Machine Cores

However, if the order is large and the equipment is constructed of material that will stand up under the stresses encountered in blowing a core, it is more economical to make the cores on the blow machine. Core boxes constructed of wood or plaster do not stand up under the continuous erosive action of sand and air.

Many types of cores, due to their shape and size, do not readily adapt themselves to the blow machine. In many cases it is more economical to make these cores on the bench.

In this plant about 90 per cent of the work is made on the blow machine. Between 80 and 90 lb. air pressure is used. The average size of the blow hole is about ¾-in., with a minimum of ½-in. and a maximum of one in. The usual practice is to start off with a ½-in. hole and work from that point. The objective in blowing a core is to get the sand and air into the box, and then get the air out as fast as possible. The proper venting, blow holes, not only size but location, and air pressure determine to a large extent the uniformity of the core produced.

Core Work

Some cores after baking do not require any further work other than unloading and placing in proper receptables. Others merely require finning, which may be due to worn equipment and improper clamping.

Still other cores must be coated to prevent metal penetration. Many commercially prepared coatings which meet these requirements are available. Cores should be coated while they are still warm in order to insure that the coating will be dry. If this is not practicable, the coated cores should be placed in a drying oven and all moisture driven from the coating.

Many times defects are caused by the improper use of coatings. Core wash manufacturers have trained technical men who will recommend the proper wash and give instructions regarding the proper application. Cores may be coated while green by dipping or spraying. Dry cores may be coated by dipping, spraying, swabbing or brushing.

Many cores are of such design or shape that it is impossible to make them as a single unit. This requires the assembly of two or more cores, and the usual practice in the malleable shops is to paste the various parts together, using a jig or specially prepared fixture. Many satisfactory pastes are on the market. Literature on the proper use of these pastes is supplied by the manufacturer. Here again the paste must be thoroughly dry before the core is sent to the foundry.

Usually, when two or more cores are pasted together the joints must be mudded up. Mudding compounds may be merely molasses and sand, clay and sand, or any of the commercial mudding compounds found on the market. Their function is to seal the joint against metal penetration. The mudding compounds must not spall off during the pouring operation and they must not produce an excessive amount of gas which may cause a casting blow.

Core Properties

Properties desired in a core are largely determined by its use in the foundry. A core must have sufficient strength to withstand the abuse to which it will be subjected in unloading, transporting to the foundry and handling by the molder. The core must be capable of resistance to erosion and deformation by the molten metal.

Ram-up cores must have sufficient strength and resilience to stand up under the jolting, ramming and squeezing encountered in making the mold. Cores must have sufficient

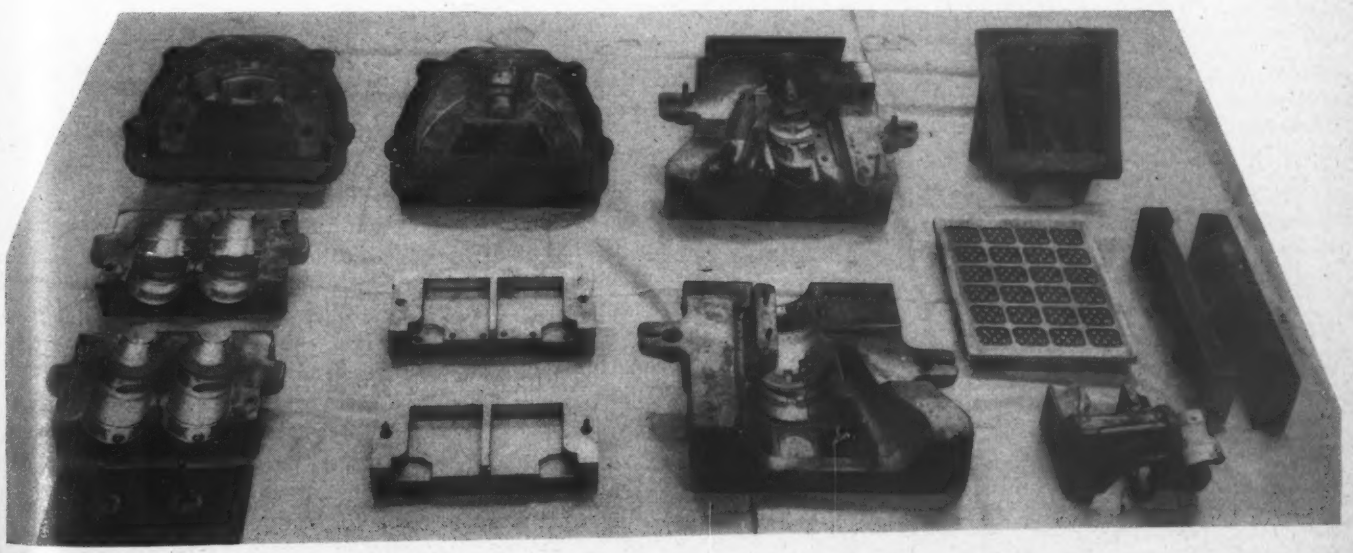


Fig. 8—Photograph showing variety of boxes used in making cores.

TABLE NO.2

	MIX 1	MIX 2	MIX 3	MIX 4	MIX 5	MIX 6
INGREDIENTS	%	%	%	%	%	%
FINE SAND					22.83	6.90
MED. SAND		47.43	52.14	53.13	46.75	63.22
COARSE SAND			23.18			
SPEC. SAND	95.74	47.43		40.84		
SCRAP SAND			18.54		22.83	22.99
CEREAL BNTR	1.07	1.40	1.74	1.40	1.03	1.03
BENTONITE					.17	
CORE OIL	.12	.24	.35	1.16	1.37	2.18
WATER	3.07	3.50	4.05	3.47	5.02	3.68

TABLE NO.3

TEST NO.	MIX NO.1 A CORE	MIX NO.2 B CORE	MIX NO.3 C CORE
1	16.0 CC GAS/GR	29 CC GAS/GR.	12.8 CC GAS/GR
2	19.5 "	13.6 "	6.8 "
3	15.0 "	18.5 "	13.4 "
4	14.1 "	14.3 "	10.0 "
5	15.4 "	13.8 "	10.5 "
6	18.0 "	12.7 "	8.6 "
7	19.6 "	13.9 "	8.8 "
8	20.0 "	15.3 "	10.6 "
9	19.4 "	13.0 "	8.3 "
10	18.7 "	16.9 "	10.4 "

TABLE NO.4

TEST NO.	MIX NO.3 A CORE
1	36.4 CC GAS/GR.
2	25.6 "
3	23.8 "
4	38.7 "
5	40.7 "
6	18.0 "
7	27.1 "
8	40.0 "
9	39.9 "
10	40.0 "

TABLE NO. 5

TEST NO.	MIX NO.4 A CORE
1	24.1 CC GAS/GR.
2	25.2 "
3	23.2 "
4	24.2 "
5	26.3 "
6	20.6 "
7	30.5 "
8	21.2 "
9	30.4 "
10	26.7 "

TABLE NO.6

TEST NO.	MIX NO.5 A CORE
1	52.7 CC GAS/GR.
2	55.7 "
3	58.7 "
4	29.8 "
5	43.2 "
6	55.6 "
7	59.1 "
8	39.5 "
9	38.8 "
10	65.7 "

TABLE NO.7

TEST NO.	MIX NO.6 A CORE
1	26.3 CC GAS/GR.
2	27.1 "
3	39.5 "
4	29.8 "
5	26.4 "
6	25.6 "
7	25.5 "
8	33.0 "
9	38.2 "
10	39.0 "

permeability to permit ready escape of the gases formed in the pouring operation. Residual gas must be low to prevent gas entering the metal and to allow the metal to remain quiet.

Cores must disintegrate rapidly after the initial set of the molten metal to prevent strains in the castings and to minimize the shake-out effort.

Core sands should be tested at regular intervals for:

1. Green permeability.
2. Green strength.
3. Moisture.
4. Baked permeability.
5. Baked strength.
6. Fineness.

In addition to the foregoing, many special tests are available. These include:

1. Gas content and gas pressure.
2. Retained strength.
3. Collapsibility.
4. Deflection.
5. Hot strength.
6. Hot permeability.
7. Expansion and contraction.
8. Blowability.
9. Sintering.
10. Spalling.
11. Warm strength.
12. Hardness.
13. Strength of core paste.
14. Moisture absorption in humid atmosphere.
15. Stickiness.

As previously stated, all sands in this foundry are tested for fineness. Typical screen analyses of these sands are given in Table 1.

Tests are run at regular intervals for green strength and green permeability. It is the practice to use green tensile rather than green compression. Green tensile strength will run from 6 to 18 grams per sq. cm. The average green tensile strength of the core sands is from 8 to 10 grams per sq. cm.

It is debatable whether green tensile or green compression is the most desirable test. Although the green tensile test is used in this foundry, perhaps green compression would tell the technician more about his cores in the green state than would green tensile. The most common defect encountered in the green state is the failure of the core to hold its shape. This defect would be caused by sagging or low green compression. However, the testing procedure makes the green compression test rather difficult to run.

Green Permeability

Green permeability of core sands is determined in the same manner as green permeability of foundry sands, and is found to run from 50 to 300, the average being 120.

Moisture is determined by the conventional oven method, and on core sand mixtures will run from 2.5 to 5.5 per cent. The six core sand mixtures given in Table 2 show moistures of 3.00 to 5.00 per cent.

Baked permeabilities vary in about the same ratio as green permeabilities. Baked permabilities usually are higher than green permeabilities. However, if the green and baked permeabilities are determined on a given mixture the difference between the two permeabilities will always be approximately the same. Once this difference has been determined the baked permeability can always be estimated from the green permeability.

Baked Strength

Three commonly used methods for determining baked strength are available; compression, tensile, and transverse. Of these three, baked tensile is perhaps used by the majority of foundries. The Core Test Committee A.F.A. is now in the course of determining which of these three tests will give the most information. This committee may find that the transverse test plus deflection may tell more about the stresses to which the core is subjected than either compression or tensile.

This malleable foundry has been using the baked tensile test, but the results have not been entirely satisfactory. The baked tensile strength of the cores will run from 50 to 350 psi. These strengths are determined not only by the percentage of binder present but by the fineness of the sand, the shape of the grain, mixing procedure, moisture content, baking procedure, length of time elapsing before cores are placed in the oven, atmospheric conditions and the presence of impurities or fines.

In the mixtures given in Table 2, baked tensile strengths obtained are:

Mixture No.	*Baked Tensile Strength, psi.*
1	60
2	80
3	60
4	120
5	100
6	275

Of the special tests previously listed, scratch hardness and gas content tests are used in this foundry's standard testing procedure.

Scratch hardness testing replaces the old method of determining hardness by scratching with the fingernail. The test is easily run and can be used on regular run of cores. Furthermore, it does not require an expert to use it. Tests have shown that no direct relation exists between hardness and strength. In a given mixture there is a direct relation between ramming energy and hard-

ness, provided that the baking has been uniform.

Hardness of the mixtures shown in Table 2 are as follows:

Mixture No.	*Hardness*	*Core Oil, per cent*
1	55-65	0.12
2	60-70	0.24
3	60-70	0.35
4	70-80	1.16
5	60-70	1.37
6	80-90	2.18

Hardness varies from 55 to 90. Generally, the hardnesses show a direct relation to the percentage of oil, but the pattern of this relation is not regular. Mixture No. 5 show a low hardness because of the presence of clay in the mixture.

Considerable work has been done on the gas contents of the core sands. Two important factors must be considered when determining the gas content of core sand mixtures, and these are time and temperature. The apparatus available for determining gas content consists of a resurrected carbon combustion furnace with rheostat temperature control, a vitreosel tube, drying tube, and a gas burette.

Vitreosel Tube

The vitreosel combustion tube is firmly packed for about half its length with asbestos, and the end sealed. The drying tube is filled with glass wool and silica-gel. It is preferred to dry the gas. The gas burette is filled with an acid solution of 10 per cent potassium sulphate.

A weighed sample is placed in a boat and this boat is placed in the furnace, which is held at a temperature of 1800° F. The sample is permitted to burn in the atmosphere of the tube for 8 minutes. The volume of gas produced is then measured. The gas content is recorded as cu. cm. of gas per gram of sample.

The sample should be representative of the core. It is found necessary to run at least five determinations and take the average. Tables 3, 4, 5, 6 and 7 list the gas contents of the six sand mixtures given in Table 2.

Gas Content

In Table 3, the gas contents are those of an assembly of three cores using sand mixtures No. 1 and No. 2. These two mixtures run fairly constant in gas content, variations being due to the degree of bake. The lower contents are caused by the start of decomposition in the bake.

Gas contents of Table 4 are not as uniform. This variation is caused by poor baking and the introduction of scrap sand into the mixture.

Variations in gas contents shown in Table 5 indicate the various degrees of bake. This is a core which seems difficult to bake properly. It reflects poor oven control. Sand mixture No. 4 is one that should bake readily.

TABLE NO. 8

SECTION	DYE	VISUAL EXAM. OF BAKE	CC GAS/GRAM	SCRATCH HARDN'S
½"	INVISIBLE	MEDIUM	26.6	60
1"	"	"	30.6	67
1½"	"	"	30.4	66
2"	VISIBLE	MEDIUM LIGHT	33.0	70
2½"	"	"	34.9	58
3"	"	"	33.8	59

Gas contents of sand mixture No. 5 listed in Table 6 show considerable variation. This mixture has a high percentage of scrap core sand. The moisture content also is high due to the addition of clay to the mixture. This mixture reflects the degree of bake and the variation in the scrap core sand.

Table 7 gives the gas content of core sand mixture No. 6, which is a hard sand. This mixture must be baked thoroughly. The variations in gas content are due to the variation in the scrap core sand used in the mixture and to the degree of bake.

Gas vs. Cereal Binder

It has been found that three conditions are responsible for the various differences in gas contents in the core sand mixtures. A direct relation exists between the gas content and the percentage of cereal binder. The use of any scrap core sand in any core sand mixture will cause a variation in the gas content. This is self-explanatory as this scrap sand may be any one of the mixtures or a combination of all of the mixtures given in Table 2. Finally, the gas content shows a relation to the degree of bake. It has been found that gas contents have helped the sand technician to determine whether the right sand mixture is being used, to detect variations in mixing, and enables him to determine whether the cores are receiving the proper bake.

Two additional tests are used for checking the bake. The first method is to introduce a dye into the mixture. The dye will disappear if the core has reached the proper baking temperature. This method has been used by several foundries not only for determining the bake but for means of identification of the vari-

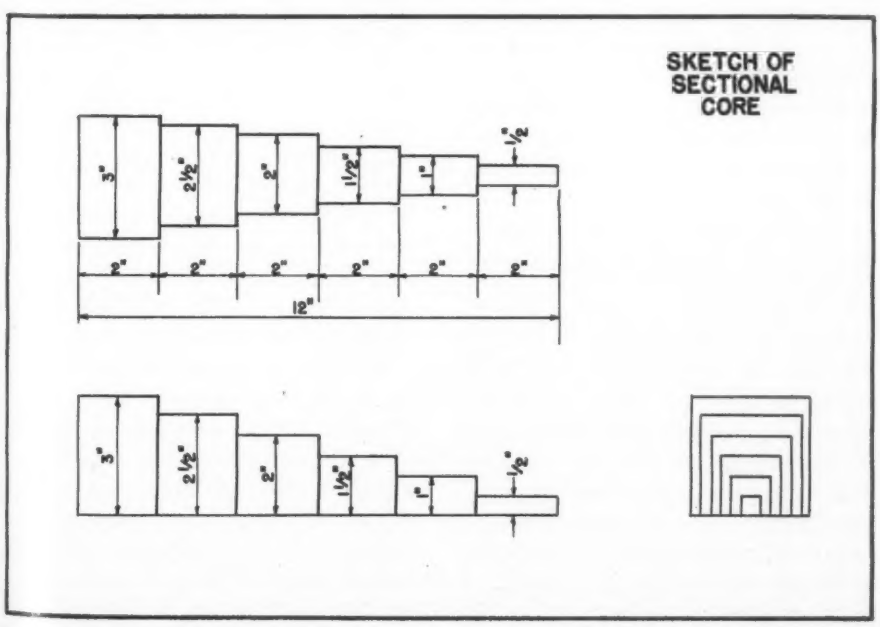


Fig. 9—Sketch of sectional core used to determine baking properties of various core sections from ½ to 3 in.

ous core sand mixtures. This foundry has found it too expensive to use in every mixture.

The second test is one that any practical coreroom man can use to determine how various core sections are baking, and is similar to Woodliff's method. It has been used in this foundry for years. A core of various sections is used instead of a one-section core. This core consists of six sections as shown in the sketch (Fig. 9). These sections vary from ½ to 3 in., approximating the sections of the various foundry cores. It is not necessary to stop at the 3-in. sections. These sections can be made to conform to the minimum and maximum core sections of the foundry.

For visual examination cores are made from any or all core sand mixtures. Sometimes it is necessary to select one specific core sand mixture and make one core for each oven. In this manner the bake on the different ovens or shelves of the ovens can be determined.

After the cores are baked the core foreman or some designated person breaks the cores into the various sections and determines the bake by visual examination. The test is carried one step further. Visual examination is checked by determining the gas content and hardness of the various sections.

Table 8 gives the gas content and hardness obtained on the sectional test, using sand mixture No. 4 from Table 2. On this test the dye was used. The dye had been completely volatilized on the ½, 1 and 1½-in. sections, but was still visible in the 2, 2½ and 3-in. sections. Hardness was fairly uniform, showing a uniform ram.

Visual examination, gas content and dye test all showed that the sections of from ½ to 1½ in. were completely baked, but the sections of from 2 to 3 in. were not completely baked. Interpreting these results, it could be expected that all cores of ½ to 1½-in. sections made from this sand mixture and baked in the same oven would be properly baked. However, if the sections exceeded 1½ in. it is probable that the cores would not be thoroughly baked.

Summary

In summarizing, the author has attempted to show that it is possible to control core sand mixtures and cores. Due to the number of variables in the making and processing of cores, the sand technician must be constantly on the alert. It has been shown that simple ways of checking some of these variables are available. The importance of the gas content test has been stressed, not only from the standpoint of producing solid castings but as a check on coreroom practice.

QUESTION AND ANSWER

A.F.A. Member Answers Pattern Storage Problem

RECENTLY A foundry in the East, contemplating the erection of a pattern storage building, requested information which might prove helpful to this project. The following is quoted from the reply of one A.F.A. member:

"It is not quite clear to me whether you would like information concerning the arrangement of patterns within the building or the handling of both patterns and records. However, I will make a few comments and hope they will be of some help.

"First, I think the type and size of the patterns to be stored, in relation to their arrangement within the building, is of vast importance. The larger patterns should be on the floor level so as to be accessible without too much lifting. As a suggestion, the storage space for large patterns would be more convenient if located near the door leading to the pattern layout floor. If space can be arranged within the pattern building for this layout floor the set-up is ideal, but usually the pattern storage building is not large enough to allow for this and it is done in another location. Also, most pattern storages are outgrown before they are long in operation, which makes a move of the layout floor necessary in any case.

"If the larger and heavier patterns are located as in the foregoing, thought should be given to aisles so that patterns can be located and removed without confusion. The remainder of the space, I imagine, would be for plate and gated patterns, and they can be placed in tiers to the extent the building will permit. In a tier arrangement, a ladder which moves on a permanently-set rail is of advantage, with catwalks built between and in front of racks. This eliminates a second floor to the building and provides better service.

"Keeping pattern records is important. The racks or floor space should be well marked in accordance with the system used. Some sort of record, preferably in file form, should be kept and marked so that patterns can be easily and quickly identified and located in the storage space. Sketches are helpful for this purpose.

"Such a record should be used to note return of patterns, and will prevent later controversies with customers.

"As an observation, I believe that most foundries do not keep a close check on their pattern records; consequently, patterns can be accumulated to the extent that no room is available for active patterns. It takes courage to check with the customer and have him remove obsolete patterns. In my opinion, patterns that are not used in two or three years should be checked out and returned to the customer if found to be obsolete. It saves handling expense and building extensions."

'American Foundryman' Wins Editors Award

HELD RECENTLY in Chicago was the annual publication contest for internal, external and trade association publications sponsored by the Industrial Editors Association of Chicago. Operating under a new contest technique the association presented 72 certificates to editors who placed first, second and third in the many different classifications.

Submitting an entry in the "Stimulation of Competition" division, Frank C. Cech's article on the "1944 Patternmaking Contest" was used to illustrate the competitive spirit among foundry apprentices in the annual apprentice contest. As a result AMERICAN FOUNDRYMAN was awarded first place in that division over a number of other entries.

Mr. Cech's paper appeared in the September issue, pages 64-67.

CENTRIFUGAL CASTING of a MAGNESIUM PART

F. P. Strieter
and
R. J. Maenner
Dow Chemical Co.
Midland, Mich.

A RING CASTING of approximately 13 in. outside diameter, 11 in. inside diameter and ½-in. thickness was chosen for experimental work on centrifugal magnesium casting because it had been made as a commercial permanent mold casting and because of its simplicity of design. It should be realized that a relatively small percentage of commercial shapes can be cast by the true centrifugal process.

Two factors probably have tended to retard the development of a process for casting magnesium alloys centrifugally. The first of these is the chemical reactivity of molten magnesium, or its tendency to oxidize readily in contact with the air. The second factor largely concerns its density. The density of magnesium oxide is greater than the density of magnesium. This factor makes it difficult to separate the dross from the metal by centrifugal force because the heavier MgO particles may be trapped by the freezing alloy.

Another point to mention here in comparing centrifugal casting of magnesium with steel or cast iron is the fact that, in steel or iron alloys, the slag is not only much lighter but is also a liquid at casting temperatures, while the magnesium dross is a solid. This combination of a low density, fluid slag makes it relatively easy to separate the slag from the metal centrifugally in steel practice.

It is interesting to note at this point that these same two factors were a problem in the early days of the sand casting of magnesium alloys. The volume and quality of magnesium sand castings today indicates that these factors were overcome in commercial practice. The balance of this discussion indicates that they can also be overcome in centrifugal casting practice.

Description of Equipment. The centrifugal casting work described here was done on the machine shown in Fig. 1. This view shows the steel mold as it is mounted on the machine. The casting is formed under the cover in an impression cut into the mold. The cover plate also fits into an impression cut into the mold and is held down during the spinning by the three "dogs" shown in the picture.

The machine is mounted so that it can be rotated through 90° allowing for casting from any angle from horizontal to vertical. The machine is driven by a 3 hp. motor equipped with a dynamic drive which allows a continuously varying mold speed with a constant speed A.C. motor. An air brake is used to stop the mold. A tachometer indicates the mold speed.

A 3½-lb. capacity ladle of the conventional teapot spout design was used to pour the castings. The metal was melted in 100-lb. magnesium capacity open pots and heated directly to the casting temperatures used in all cases. The metal was not given any grain refining treatment. The alloy used was ASTM alloy AZ92 (9Al-2Zn-0.2Mn). This is the same alloy, and metal preparation treatment, as used on the static casting to which the centrifugal casting is being compared.

Discussion of Experimental Results. Centrifugal casting of AZ92 alloy requires that a definite technique be followed in order to produce good quality castings. Table 1 indicates the results of various casting temperatures, mold speeds and pouring methods. Pits, microporosity, lapping or cold shutting, and banding can occur under certain conditions.

Pitting is caused by excessive turbulence of the metal as it flows from the ladle into the mold. In normal sand or permanent mold casting the metal is bottom gated or side gated into the mold to eliminate turbulence. In centrifugal casting the metal is, in effect, top gated because it flows into the mold in the direction of the centrifugal force.

In order to reduce to a minimum

Centrifugal casting of cast iron, steel and the heavy non-ferrous alloys is an old practice. Relatively little work, especially in production, has been done on the centrifugal casting of light alloys. Investigation has shown that a commercial magnesium casting can be made successfully by the true centrifugal permanent mold process, the product being equal to or better in quality and efficiency than that obtained in static permanent mold casting.

This paper was presented at an Aluminum and Magnesium Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6, 1946.

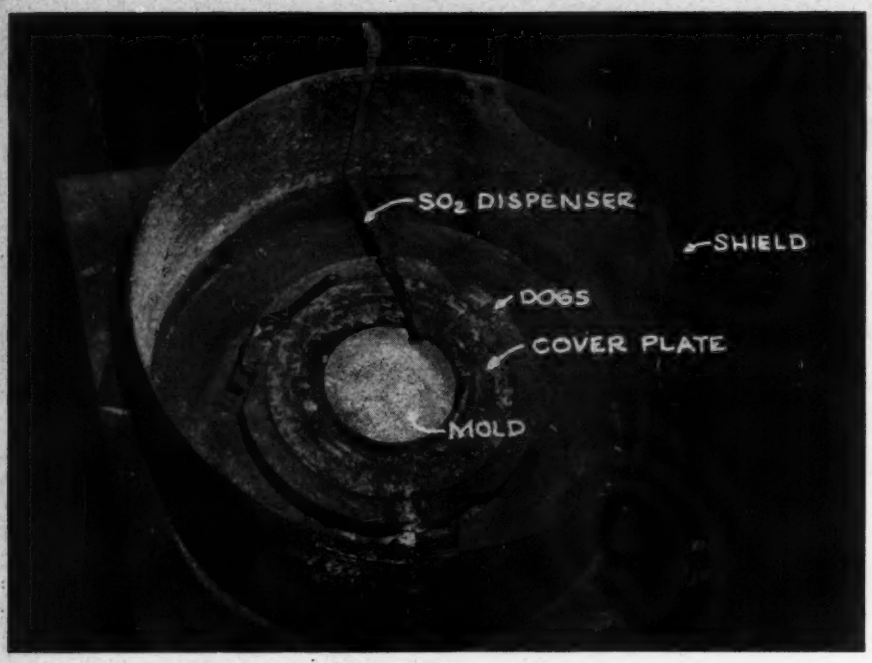


Fig. 1—Front view of centrifugal casting machine.

Table 1

EFFECT OF CASTING CONDITIONS UPON QUALITY OF CENTRIFUGALLY CAST RINGS

Mold Speed, rpm.	*Mold Temp., ° F.*	*Metal Temp., ° F.*	*Type of Pour**	*Quality Rating***	*Defects*	*Physical Properties as Heat Treated and Aged* — *Tensile Strength, 1000 psi.*	*Yield Strength, 1000 psi.*	*Elongation, per cent in 2 in.*	*Grain Size, 0.001 in.*
600	600	1375	P	E	Porosity, Pits, Lapping				
800	600	1240	P	C	Lapping				
		1300	P	C	Lapping, Pits	37.3	26.2		5
		1375	P	C	Porosity, Slight Lapping	39.3	28.7	1.4	5
1000	600	1240	P	B	Slight Lapping and Pits	36.5	28.8	1.0	3
		1300	P	A	None	36.9	25.3	1.8	4.5
			O	D	Pits				
		1375	P	A	None	37.0	24.9	1.4	4.5
			O	D	Pits				
1200	600	1240	P	B	Banding, Lapping	37.0	28.6	1.2	3
		1300	P	D	Banding	38.9	30.3	1.2	3

NOTE: Fast pour used for castings in above table to avoid lapping. Also, a 30° mold angle was used for ladling convenience.

*P—Peripheral pour. O—Center pour.

**Key to Quality Rating: A—Excellent, acceptable for production. B—Good. C—Fair. D—Poor. E—Bad.

Table 2

COMPARISON OF PROPERTIES OF CENTRIFUGALLY CAST AND STATICALLY CAST PERMANENT MOLD RING

Casting Method	*Temp., ° F.*	*Tensile Strength, 1000 psi.*	*Yield Strength, 1000 psi.*	*Elongation, per cent in 2 in.*	*Grain Size, 0.001 in.*	*No. of Values*
Static	1240	31.1	21.6	1.3	9	6
	1300	29.9	21.4	1.0	9	5
	1375	31.3	20.8	1.2	11	5
Centrifugal*	1240	36.5	28.8	1.0	3	4
	1300	36.9	25.3	1.8	4.5	10
	1375	37.0	24.9	1.4	4.5	10

*Only "A" and "B" quality rings considered. All rings spun at 1000 rpm. with peripheral pour.

the "drop" of the metal from the ladle spout to the outside diameter of the mold, it was found that the opening in the cover plate should be as large as possible, leaving only enough room for the casting and the riser. The riser, of course, in true centrifugal casting consists merely of excess metal on the inside diameter of the casting. The spout of the ladle should be placed as close to the inside diameter of the cover plate as possible.

Centrifugal Pour Types

In Table 1 this type of pouring is classed as a "peripheral" pour as compared with a "center" pour. Figure 2 shows diagrammatically the manner in which the metal is scattered with various types of pour. For minimum turbulence the metal should not only enter the mold near the periphery, but the mold should also be spinning in the proper direction consistent with the type of ladle used. It is evident that the method shown in Fig. 2C produces the least amount of pitting.

Another common method for reducing turbulence in centrifugal casting is to start pouring the metal at a slow rotational speed of the mold and to accelerate the mold as the pouring progresses. This method was tried on this casting, but no obvious improvement in quality resulted from the slower initial speeds.

However, the relatively small volume of metal poured and the rather slow acceleration of the mold may have been responsible for the lack of improvement, since the metal probably had frozen before the mold reached its top speed.

Cleaning the Metal

Oxide particles and skins are other defects which are caused by excessive turbulence, especially at the higher pouring temperatures. The same precautions are necessary in centrifugal casting as in sand or permanent mold casting with respect to cleaning the metal in the pot and protection of the metal in the pot and ladle.

Again, the peripheral pour with the mold spinning in the proper direction relative to the ladle design produces the least turbulence and hence the least amount of burning. The mold should be flushed with SO_2 gas prior to each casting.

Lapping or cold shutting is the

term applied to the defect which may occur on the outer diameter of the rings. It is caused by turbulence and low metal temperatures together with low mold speeds. The reason for it is that small globules of metal break away from the main stream of metal and are thrown against the outside of the cavity.

These globules then freeze against the mold surface and do not entirely weld into the main body of the casting. Slow or discontinuous pours also cause lapping because the metal at any point in the casting freezes before the next layer of metal is added to it.

Microporosity is caused by lack of sufficient feeding of the metal from the riser to the casting. Under the conditions of the test, there was a greater tendency of microporosity at the higher casting temperatures. It was found that the microporosity was eliminated at these higher temperatures by going to higher mold speeds, which produce more efficient feeding from the riser.

Banding is caused by vibration of the mold. This is a function of machine design and support. The mold used in this work vibrated noticeably at 1200 rpm. and caused a considerable amount of banding. The banding consisted of concentric rings

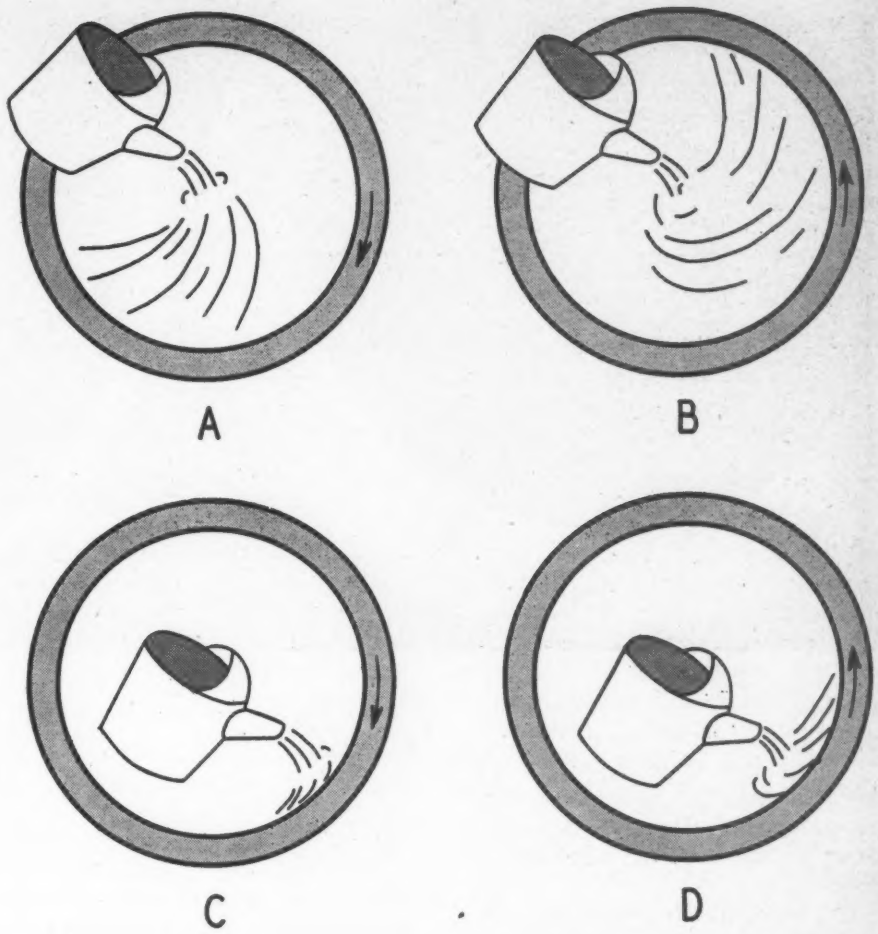


Fig. 2—Sketch showing various methods of pouring. A—Clockwise rotation, center pour. B—Counterclockwise rotation, center pour. C—Clockwise rotation, peripheral pour (least turbulence and exposure of metal to atmosphere). D—Counterclockwise rotation, peripheral pour.

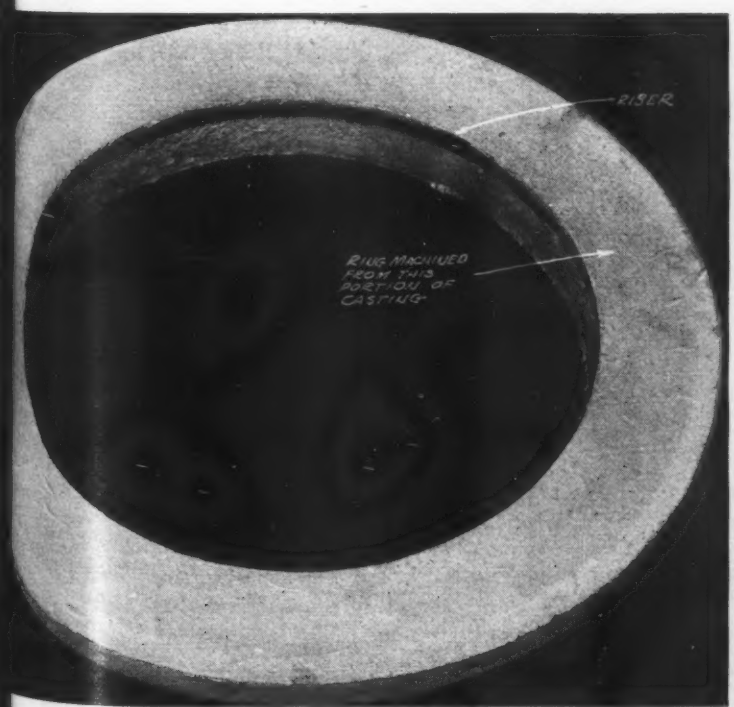


Fig. 3 (above)—Photograph of centrifugally cast ring.

Fig. 4 (right)—Photograph of statically cast ring.

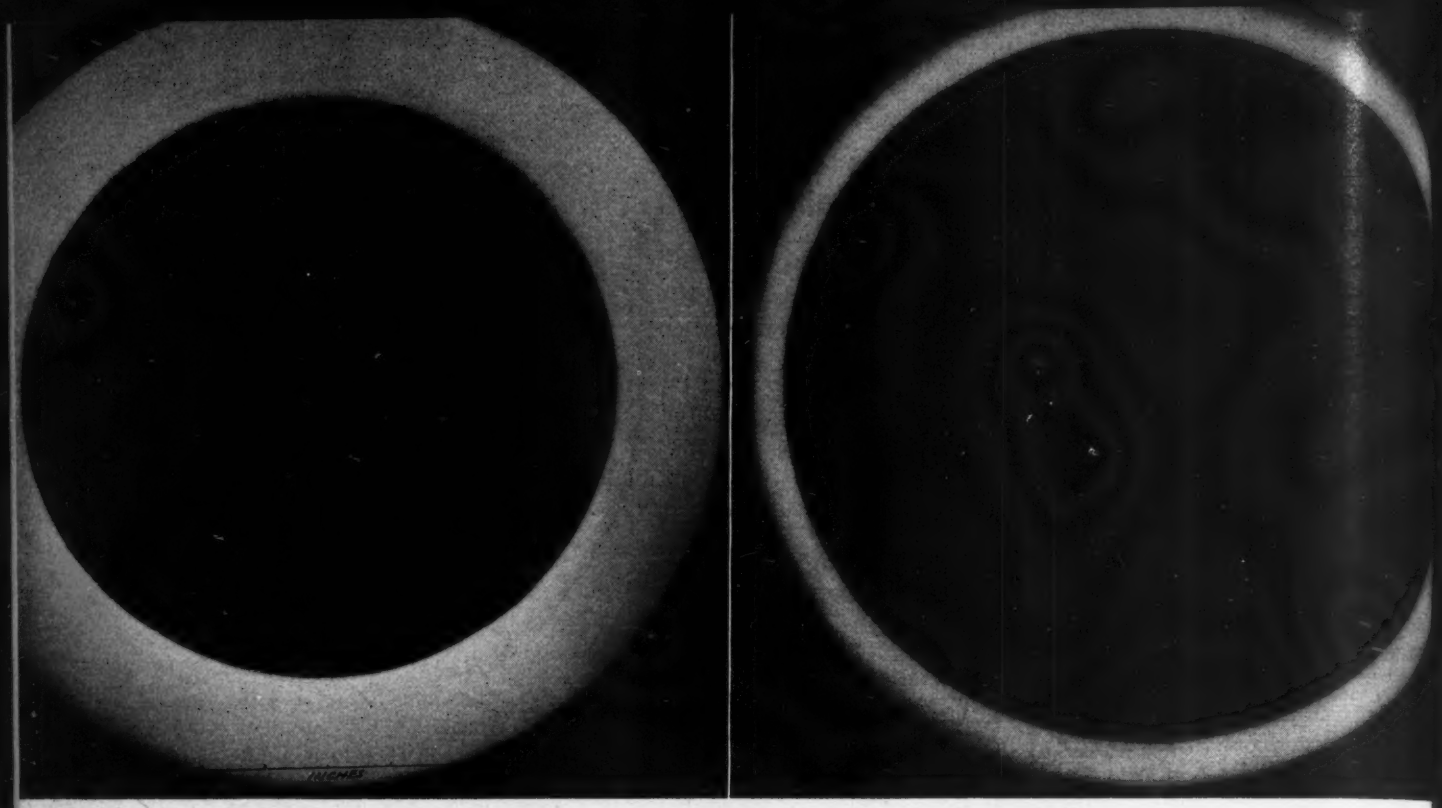


Fig. 5 (left)—Radiograph of centrifugally cast ring. The casting appears perfectly sound. Fig. 6 (right)—Radiograph of statically cast ring. Some porosity is apparent.

of porosity running partially or completely around the casting.

Considering these defects, it may be seen that the best castings can be produced by maintaining a balance of the casting conditions as follows:

1. Mold speed about 1000 rpm.
2. Metal temperature about 1300-1400° F.
3. Mold temperature about 600° F. The mold, under continuous operating conditions without supplying additional heat, operates at this temperature.
4. Peripheral pour with the direction of mold rotation such as to produce a minimum of turbulence (Fig. 2C).
5. Fast pour.
6. Mold angle about 30° from the vertical for ease and convenience in getting the ladle spout close to the mold.
7. Care in holding and ladling metal from the pot to obtain clean, flux-free metal, as is required in all casting methods.

Under these conditions, all of the defects considered are reduced to a minimum and castings of satisfactory quality are consistently obtained.

Comparison of Static and Centrifugal Casting. The same casting was produced statically in a permanent mold for comparison. A comparison of the quality and economy of the two methods of making the same casting indicates that the centrifugal casting can be made at least as inexpensively as the permanent mold casting, and it is of a better quality.

The pouring temperature of the static casting is about 1200-1250° F. in production. However, some castings were made at 1300-1400° F. in the static mold in order to compare the two methods at equal temperature.

Figures 3 and 4 are photographs of the centrifugally cast ring and the statically cast ring, respectively, showing the gates and risers in both cases. A saving in the amount of metal cast centrifugally over the amount required statically is evidenced in these two pictures. The casting as shipped weighs 1.53 lb. The permanent mold casting weighs 6.6 lb. for a casting yield of 23 per cent, while the centrifugal casting weighs 2.8 lb. for a casting yield of 54 per cent.

Both types of castings were poured with a refractory wash on the molds.

Table 3

COMPARISON OF CENTRIFUGAL TO STATIC METHOD OF CASTING

	Centrifugal
Grain Size	Better
Tensile Properties	Better
Casting Yield	Better
Casting Speed	Equal
Radiographic Quality	Better
Cleanup	Equal
Fracture Cleanliness	Equal

The thickness of the wash and the variation in thickness from riser to casting is very important in the permanent mold casting. On the centrifugal mold the wash is far less critical.

Typical prints of radiographs of the rings cast by the two methods are shown in Figs. 5 and 6. While the prints are not as clear as desired, some porosity can be seen in the static casting. The centrifugal casting appears perfectly sound.

Comparative Properties

A comparison of the heat treated and aged tensile properties and grain size of the two casting methods is shown in Table 2. This table indicates a considerable improvement in the grain size as a result of the centrifugal casting process. The metal was not given any grain refining treatment, and yet the grain size is equivalent to that obtained statically only when the metal is intentionally grain refined.

The grain refinement probably is caused by the additional chilling effect obtained in centrifugal casting since the casting is held more tightly against the mold walls. The improvement in tensile properties is due to a combination of the improvement in soundness as well as the refinement of the grains.

About 24 to 30 static castings can

be made per hr. by one man on one mold under the present operating conditions. One man can cast the same number of rings at the present time on the centrifugal machine. By designing the casting cavity into the cover plate, and by using two or more cover plates, one man probably can make considerably more castings per hr. by this method.

It is estimated that the cost of machining the centrifugal ring is about the same as for the static ring. The centrifugal casting requires a lathe cut to remove the inside material which acts as a riser, while the static casting requires a saw cut around the outside to remove the combination gate and riser.

A summation of the comparison between the permanent mold casting and the centrifugal casting indicates that the centrifugally cast ring is superior to the statically cast ring in quality, and is somewhat better than the static casting in economy of production. Table 3 indicates the comparison between the two methods. A large scale production run was not made with the centrifugal process because of contract cancellations following the end of the war.

DETROIT CHAPTER

Meets in Rackham Memorial Building

HOLDING ITS SESSIONS in the Horace H. Rackham Educational Memorial, the Detroit chapter participates in an undertaking of great civic and cultural importance to its community. The Memorial building, located in Detroit's noted art center, is part of a group designed for the advancement of specialized cultural phases of human endeavor.

Behind the ideal surroundings and facilities available to the chapter for its discussions, through its affiliation with the Engineering Society of Detroit, is the idealism of the late Horace H. Rackham and the trustees of his estate, as well as years of planning and effort on the part of Detroit engineers.

Dedicated in 1942

Dedicated in January, 1942, the Horace H. Rackham Educational Memorial is the headquarters of the Engineering Society of Detroit and certain agencies of the University of Michigan, Ann Arbor, Mich. The engineering wing of the Memorial provides for the use of affiliate societies, the small auditorium, committee rooms, and the banquet hall; while arrangements can be made by member societies for use of the main auditorium which has a seating capacity of one thousand and is completely equipped for motion and still picture projection.

Committee meeting rooms are located on the second floor of the engineering unit, and a number are available of different capacities to accommodate the varying needs of different groups. Movable partitions quickly transform a number of small rooms into a single unit for large meetings.

The small auditorium, reserved for the exclusive use of the Engineering Society and its affiliated groups, is on the first floor; and seats 300. Seats are tiered. The stage is equipped for every type of technical demonstration, and serves only as a speakers' platform or demonstration area. Projection room, full screening facilities, and adjacent checkroom accommodations are available. This auditorium can function jointly with the main auditorium through intercommunicating public address systems.

(Top)—Front view of Rackham Memorial from Farnsworth Avenue. (Bottom)—Small auditorium reserved for engineering society members only.

Foundry Is Installed in Minneapolis School

COMPRISING PART OF an industrial metal unit at Central high school, Minneapolis, is a complete foundry, including core oven, tumblers, brass furnace and electric riddle, first equipment of its kind in a Northwest public school, according to Clifford K. Lush, director of vocational education, Minneapolis public schools.

Beginning with the next school year, Mr. Lush indicated, foundry training will be available at Central high school for veterans enrolled in on-the-job training in the school, to evening extension classes and regular students.

Formerly installed in a national youth administration camp, the foundry was purchased by the state and turned over to the Minneapolis public schools for instructional purposes.

THE FOUNDRY IS A GOOD PLACE TO WORK

THE AMERICAN FOUNDRY industry needs thousands of men to bring its working force up to peacetime standards.

Foundries met wartime demands for castings with small, inexperienced crews by working long hours. Now troubled with a shortage of men, foundries find it difficult to meet reconversion and reconstruction demands for castings. Great tonnages of castings needed by other industries are being supplied slowly because foundries lack sufficient workers with adequate training and experience.

Workers can be obtained by convincing job seekers that the foundry is a good place to work. This is one of the objectives of the A.F.A. Educational Program.

Chapter Educational Activities

Promotion of A.F.A. educational activities has been intensified during the last year through the efforts of chapter educational committees. These committees, consisting of chapter members, educators and civic leaders, have carried on a variety of activities designed to interest the public and prospective foundry workers in the foundry industry. With "The foundry is a good place to work" as a theme, A.F.A. chapters have cultivated relations with schools of all types, sponsored special apprentice or student meetings, held exhibits, provided speakers, have aided in securing training films and teaching aids, and arranged visits to foundries. Local promotion of the A.F.A. National Apprentice Contest is often a responsibility of the chapter educational committee.

A two-fold purpose of educational activities is recognized by chapter educational committee members. An immediate need exists for securing good workers to enable the foundry industry to produce castings essential to reconstruction and reconversion. These workers must come from among ex-service men, recent trade and high school graduates, and former foundry workers transferring from other industries.

Importance of Castings

The second reason for intensive and continuous educational work lies in the need for instructing the general public in the importance of castings to them, and to acquaint them with the true nature of foundry work. The feeling that a foundry job is undesirable has to be changed. This attitude, built up as a result of many years of misinformation, requires an educational campaign which reaches young pupils and parents. The result expected is a more favorable attitude toward foundry jobs in future years.

"I didn't raise my boy to be a molder!" is the objection of many mothers on discovering their sons are considering jobs in the foundry industry. A sudden falling off in enrollment of a proposed high school foundry course from 32 to 4 experienced recently in one chapter area was the result of this unfortunate feeling. Whether they intended to go into foundry work or not, these boys have been deprived of the chance to become acquainted with one of the most interesting and basic phases of the entire metalworking field.

Prejudice against foundry work is harmful to the industry and prevents young men, who would be successful foundrymen, from entering a basic industry. Parents would rather have their children work in a white collar job for less money than earn higher wages on a job they think lacks social prestige. They do not recognize, according to A.F.A. Past President F. J. Walls, "That opportunity is going around in a suit of work clothes."

The campaign to combat prejudice against the foundry must be carried to the public and must be waged within the industry itself. Pamphlets discussing the various phases of the foundry industry are expected to be helpful by bringing first-hand information to people unfamiliar with foundries. Distributed through employment bureaus, libraries, veterans separation centers and counseling bureaus, schools and clubs, the series of pamphlets will fill a long felt need. A pamphlet directed at present foundry workers, encouraging them to bring their sons into the foundry, is expected to be helpful.

Management Has Responsibilities

The foundry industry has to prove, however, that the foundry is a good place to work, or other efforts will be of little value. Foundries cannot expect to benefit from the A.F.A. educational program if they cannot demonstrate to a job seeker that he is entering a well-organized, safe, progressive plant. Foundries below the industry average in housekeeping will have to im-

prove or a prospective employee will lose interest the moment he steps onto the foundry floor.

The within-industry phase of chapter educational activities requires close cooperation with foundry management. This is discussed by E. W. Horlebein, A.F.A. National Director, in an editorial in the January issue of AMERICAN FOUNDRYMAN. Warning that lip service cannot substitute for action, National Director Horlebein points out the need for improved training programs and better working conditions. As a member of foundry management, he unhesitatingly lays the problem on management's own doorstep in asserting that, "The problem is one that rests mainly with top management of our foundries . . . a frank discussion of such related items as working conditions, shop practices and broader thinking about the future of foundry industry is essential."

Management meetings, which have been successful in several chapter areas, are expected to be valuable in convincing foundry owners and managers that they have an important responsibility to themselves and to the foundry industry.

Foundry Offers Training

Many convincing arguments illustrate that the foundry is a good place to work. Believing that "the more you learn, the more you earn," most job seekers today look for work in a plant where they will be trained while they earn a living.

According to A.F.A. estimates, 2300 of America's foundries offer apprentice training. The nature of the training varies with the size and type of foundry. Small foundries may take only one apprentice a year; larger foundries may have apprentice classes of 25 or more. Training always includes considerable practical work right on the job, and usually includes related training. This is special classroom instruction given in local vocational schools or in the plant by regular employees of the foundry.

Educational institutions often cooperate with foundries in providing complete foundry training courses, including advanced training for foremen.

Some foundry jobs do not require an apprenticeship. In foundries where some work is highly repetitive, workers may be taught to perform certain tasks after a few weeks of intensive training. Short term training used in some foundries fits an individual for limited foundry service by rapidly training him to work at one of several jobs in a single department.

Workers trained under the upgrading system spend only a few weeks learning to do a given job. Having a minimum of training and skill, these men do not provide management with a flexible working staff because they must be trained to do each new job to which they are assigned.

Offers Good Wages

A question often asked of chapter educational committee members is: "What do foundry workers earn?"

Foundrymen earn wages equal to and above those earned in many other industries. Salaries vary depending on local conditions, therefore, a specific wage cannot be set for the industry. However, according to recent U. S. Department of Labor statistics, wage rates for male workers in key occupations in machinery industries placed:

Patternmakers above tool and die makers,

Bench molders above electricians and welders,

Floor molders and hand coremakers above sheet metal workers, heat treaters, mechanics and carpenters.

Machine molders above drill press operators and many other machine tool operators, painters, truck drivers and stock clerks.

Foundry workers have homes, raise families and send their children to college, own automobiles, go hunting and fishing, play golf, participate in church activities, are active in civic affairs, and live a life as full and interesting as most people do. Many foundrymen enjoy hobbies ranging from gardening and bee-keeping to model making, leading Boy Scouts, even to directing the philharmonic orchestra of one of America's foundry centers!

Opportunities for Veterans

Veterans have found chapter educational committees helpful in learning of, and securing, foundry jobs. Former service men usually are interested in jobs which have a future, which offer training, and which allow them to support themselves or family while working.

Veterans can earn production workers' wages while training under any type of plan approved by local offices of the Veterans Administration. Many foundries have obtained approval and are operating training courses for veterans eligible for benefits under the *G. I. Bill of Rights* or the *Vocational Rehabilitation Act*. These may be standard apprentice training courses, short term training, or up-grading training systems.

Skills acquired in service have helped veterans get foundry jobs or advance faster in foundry work.

Veterans applying for foundry work receive special consideration from some foundries pledged to make up 25 per cent of their jobholders from ex-service men and women.

Offers Employment Everywhere

Some workers prefer to work in one locality or for one company, while others want to move periodically to other cities offering employment in the type of work most familiar to them. To the latter type of worker it is helpful to point out that there are more than 5600 foundries in the United States, Canada and Mexico.

Foundries are located in every state. Although concentrated in industrial areas, such as Pittsburgh, Cleveland, Chicago, Buffalo, Detroit, New York, Milwaukee, Birmingham, St. Louis, Los Angeles, etc., many foundries are located in small suburban towns and in rural areas.

Most of the foundries of Canada are in the provinces of Ontario and Quebec, with a lesser number in British Columbia and a few scattered throughout other provinces.

In Mexico many foundries are situated in Mexico City and others are located in manufacturing, mining or sugar centers.

Security and a job with a future are important to most prospective employees. Chapter educational committees clinch their argument that the foundry is a good place to work by pointing out the importance of castings to everyone. Castings are fundamental to the economic development of a community or a nation. Everything used and produced requires metal castings, directly or indirectly. If a nation prospers, its foundries are active, employment is

good, and skilled men are in great demand.

After a time of economic depression, foundries are among the first plants to reach full employment and production. This is true because all other industries need castings.

Educational Committees Appointed

Recognizing the importane of local action, many A.F.A. chapters have organized committees to act as focal points for foundry educational activities. The following list, for chapters known to have educational committees, shows committee chairmen directing local educational activities: *Central Indiana,* Robert Langsenkamp, Langsenkamp-Wheeler Brass Works, Inc., Indianapolis; *Detroit,* C. W. Silver, Michigan Steel Casting Co., Detroit; *Eastern Canada and Newfoundland,* Henry Louette, Warden King Ltd., Montreal, Que.; *Metropolitan,* Fred Sefing, International Nickel Co., New York; *Northeastern Ohio,* John H. Tressler, Hickman, Williams & Co., Cleveland; *Northern California,* Samuel D. Russell, Phoenix Iron Works, Oakland, Calif.; *Northern Illinois and Southern Wisconsin,* R. W. Mattison, Mattison Machine Works, Rockford, Ill.; *Northwestern Pennsylvania,* L. A. Dunn, General Electric Company, Erie, Pa.; *Philadelphia,* C. L. Lane, Florence Pipe Foundry & Machine Co., Florence, N. J.; *Texas,* L. H. August, Hughes Tool Co., Houston, Texas; *Twin City,* Clifford Anderson, Crown Iron Works, Minneapolis; and *Wisconsin,* David C. Zuege, Sivyer Steel Casting Co., Milwaukee.

Chapters which have not formed an educational committee, or announced the personnel of any committee devoted to educational activities are requested to do so. Names and addresses of committee members should be sent to American Foundrymen's Association, 222 West Adams St., Chicago 6. This information is needed to aid in keeping chapters informed of A.F.A. educational work and developments in other chapters.

Chapter educational committees are sales representatives for the foundry industry. The fifth largest in America, the foundry industry needs representatives everywhere who can convince the public and prove that the foundry is a good place to work.

NEW YORK CHAPTER HEARS

Talk on Precision Casting Manufacture

THE VARIOUS STEPS in the manufacture of "Precision Castings" were shown at the February 1946 meeting of the Central New York Chapter of A.F.A. in a talk by H. P. Gray, Gray Mfg. Co., Syracuse, N. Y. Samples of wax patterns used in the process, and ceramic molds and castings from the various steps of the process, were on display as well as a wide variety of finished parts made from ferrous and nonferrous alloys.

Mr. Gray first covered the history of precision casting, outlining the applications of the process from the time of Benvenuto Cellini and his bronze castings of Perseus and Medusa around 1540, to adoption of the process to the modern dental industry and jewelry trade. He also described further developments during World War II in the manufacture of turbine blades of high-temperature alloys, and present application of the method to the manufacture of small parts.

The method was stated to be applicable to a wide range of alloys such as aluminum, copper alloys including beryllium copper and the bronzes, carbon steels, tool steels, stainless steels and the non-machinable high-temperature resistant alloys. Smooth surface finish and close tolerances of as much as 0.005 in. per in. of length and better were brought out as every-day practice in the precision castings industry.

The speaker discussed the strength of the ferrous alloys and the ability to heat treat by ordinary methods so as to obtain strengths equivalent to those of heat-treated bar stock. In general, he said, the parts as-cast are in a condition suitable for ready machining. Grain structure is comparatively large and can be refined by normalizing.

The relative place of precision castings in the industrial field was emphasized and typical cost figures given for some of the parts exhibited. It was brought out that precision castings are not a "cure all" for solving all of the small parts problems. Parts that can be normally processed by screw machine and by stamping cannot be cast competitively unless the casting is an assembly of three or more individual screw machine parts and stampings. Die castings are more economical if the user is able to utilize die-casting materials.

On small quantity runs, where the cost of dies is high, there may be an opportunity for precision casting to become competitive due to lower cost of tooling up. Powdered metal parts, for large runs and simple shapes, are more economical than precision cast parts. Precision castings can become competitive if the part is subject to shock, and precision castings will withstand impact better than will powdered metal parts.

Precision casting was described as having a definite place in the small parts field and as having established itself as a permanent new industry. Its principle application is in the saving of expensive machining operations on small parts, and as a method for obtaining desired shape from the non-machinable alloys. It was also emphasized that the process gives the tool and machine designer an opportunity to design parts, at reasonable expense, for performance that otherwise would be considered impractical from a cost standpoint.

A.F.A. in New Council

REPRESENTING A.F.A. in The Engineers Council, recently organized at Buffalo, N. Y., to sponsor engineering, technical and scientific activities, are J. L. Yates and H. W. Winte, both of Worthington Pump & Machinery Corp., Buffalo.

Mr. Yates, elected interim council secretary until June 1, is the author of a technical paper on "Mechanical Shakeouts," presented at the A.F.A. Golden Jubilee Convention in Cleveland. Mr. Winte, an active member of several A.F.A. National Committees, serves as Vice-Chairman, Committee on Chill Tests, Gray Iron Division.

Among member societies of The Engineers Council, in addition to A.F.A., are: American Chemical Society, American Institute of Chemical Engineers, American Society for Metals, and American Society of Mechanical Engineers.

PRESSURE FEEDING IRON CASTINGS

Large castings in all metals have always presented a feeding problem. Further development of the "narrow-neck" riser to create a pressure has made possible, in most cases, adequate feeding of the casting with only one riser.

W. J. Bradley
Dominion Engineering Works Ltd.
Montreal, Quebec

LARGE CASTINGS, whether made of steel, bronze or cast iron, always present a feeding problem. In the past, in order to properly feed a casting, it was customary to place as many risers as possible on it. These risers were placed on each heavy section of the casting, and each riser had to be fed (or churned) by a man using a feeding rod. A casting such as a large gear blank, for example, would require as many as six or seven risers, with a man at each riser. In using this method there was always the possibility of the casting being rejected due to either improper feeding of a riser, or breaking off the feeding rod in the riser.

Pressure-Fed Risers. This type of riser has been developed from what was originally known as the "narrow-neck" riser, which previously was used with good results and greatly facilitated cleaning and chipping of the castings. The narrow-neck riser has been further developed to create a pressure in addition to the narrow-neck feature, with the result that, in most cases, it is now necessary to use only one riser instead of several.

Pressure-fed risers are of two types, varying only where they join the casting. One is the narrow-neck type, as previously mentioned; the other is known as the "screen" type.

Narrow-neck risers are made with one hole, varying from ¾ in. to 2 in. or more, in the center of the cake core where it joins the casting. The screen type riser differs from the narrow-neck type in that it has a group of small holes, varying from ⅜ in. to ½ in. in diameter, in the cake core joining the casting. A cake core of 10-in. diameter would have approximately 30 of these small holes. The size of the holes in the cake core in both types of risers is governed by the size of the casting and the section which is to be fed. Figure 1 shows a sketch of these two types of risers.

Both types of risers have their special uses, but the screen type is beginning to be considered the better of the two due to the fact that the narrow-neck type has a tendency to "draw" around the neck of the riser if the feeding conditions vary. The number of holes in the screen type eliminates this condition as, if the metal freezes in one or more holes, a sufficient number of holes are still feeding freely to prevent any "drawing" action.

Placing the Riser. One of the first and most important steps is the decision as to where the riser is to be placed on the casting, preferably at its heaviest section. The next step is the gating of the casting in a manner which will allow progressive solidification in the direction of the section which is being fed. When these two items have been decided,

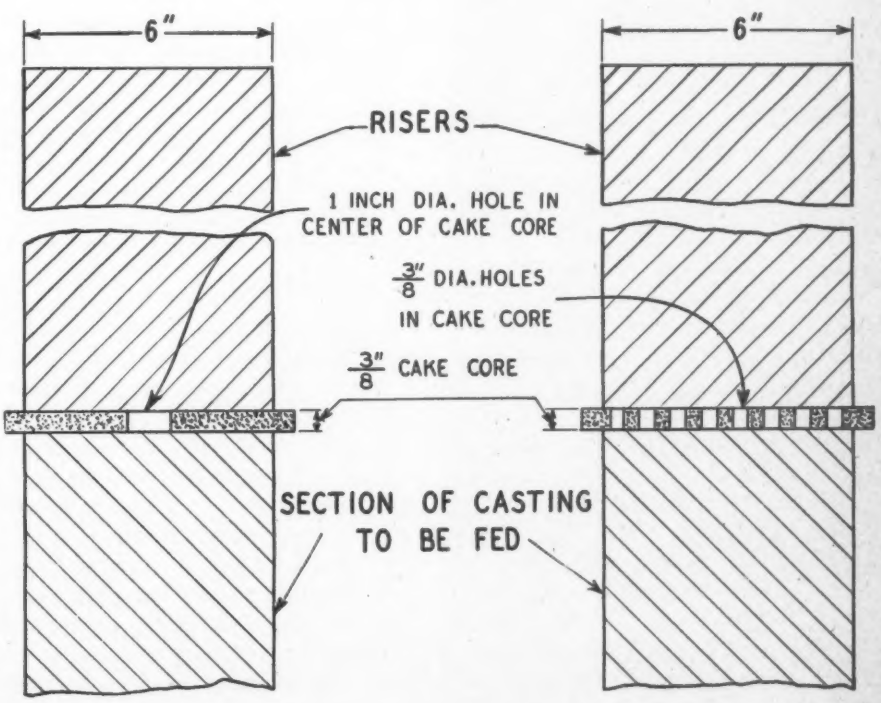
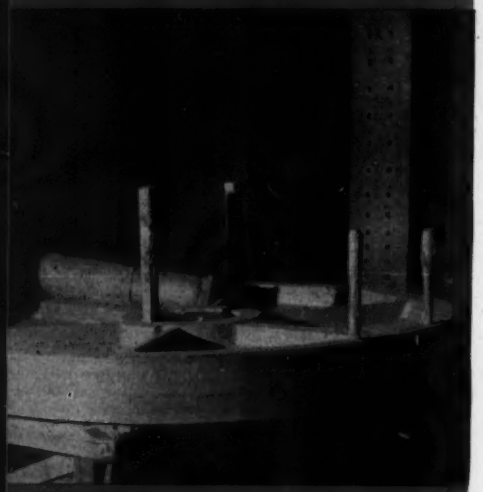


Fig. 1—Cross-sectional views of (left) narrow-neck riser and (right) screen-type riser.



Reading (left) top to bottom:

Fig. 2—Large gear blank casting—weight about 4,000 lb. One narrow-neck type riser used.

Fig. 3—Casting of split worm wheel blank—weight, 2,500 lb. Two narrow-neck risers used, one on each side of split.

Fig. 4—Gear blank casting—weight, 2,500 lb. Note absence of porosity where wheel joins rim.

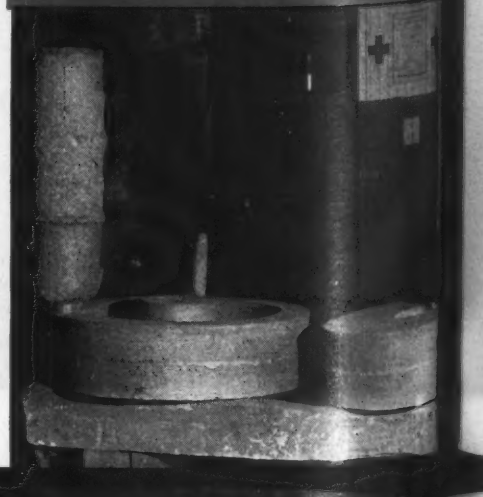
Fig. 5—A large crosshead for a hydraulic press—weight, 8,000 lb. Casting gated on the side and one pressure riser on top.

the size of the riser can be ascertained and the operation of making the riser may proceed.

Making the Riser. Risers should be sufficiently large to allow for the complete feeding of the casting, and the ruling in the average case is that the diameter of the riser shall be from one to one and one-half times the diameter of the section to be fed. In the case of large castings with extra heavy sections, this rule cannot be applied, and foundry experience would be about the only guide on which to base a decision.

Once the size has been established, actual operation of making the riser may proceed. This riser is made with a cake core, which core should be as thin as possible so that it will become incandescent and keep the hole or holes open to allow feeding. The average thickness of the core is from approximately 3/8 to 1 in.

The majority of the cores are



Reading (right) top to bottom:

Fig. 6—Large frame housing for rubber mill—weight 10,000 lb. Two risers used on this casting.

Fig. 7—Large counterweight casting—weight, 7,000 lb. One riser at one end and gated at opposite end.

Fig. 8—Example of small casting, 300 to 500 lb., which can be cast with the pressure-fed type of riser.

Fig. 9—Other types of small castings suitable for the use of pressure-fed risers.

Fig. 10—Chill castings used in making chill rolls—weight, 5,000 lb. each. Bores must be free of porosity.

Fig. 11—One of the chill castings (Fig. 10) machined and ready for use.

made from oil sand and can also be made from black sand, but the dry strength of either sand must be high. The cake core is placed on the pattern, a riser plug placed on top of the core and then rammed with the cope. The riser plug should be of the same, or larger, diameter as that of the section which is to be fed.

After the cope has been made ready for closing, the riser should be extended to the desired height above the casting, the average height of the risers being about 30 in. This extension should be dried or skin dried to correspond with the mold.

Pouring the Casting. When the mold is ready it should be poured as hot as possible, and when the metal enters the riser the pouring should be stopped. This can be gauged by having a flow-off through the top of the cope, or by watching for the metal to enter the bottom of the riser.

Exothermic Compound

The metal in the riser should then be covered with an exothermetic compound and the metal in the pouring basin frozen with water. When this has been done, hot iron should be poured into the riser and again a good covering of exothermetic compound used. As the compound seals the top of the riser the head of metal makes it possible to obtain static pressure as high as 20 psi.

A number of photographs have been selected to illustrate the large variety of castings produced by this method and the types and number of risers used on each casting.

Figure 2 shows a large gear blank weighing about 4,000 lb. One narrow-neck type riser was used and placed on the rim, which is the heaviest section of the casting.

Two pop gates are placed on the rim of the gear blank opposite the riser, and two flow-offs are placed on the hub to allow the gas to escape and to warn the pourer when the mold is filled with metal. This gating insures a good distribution of metal in the mold, with the cool metal going into the hub.

Figure 3 is a photograph of a split worm wheel blank weighing 2,800 lb. Two narrow-neck risers are used, one being placed on each side of the split.

Figure 4 shows a gear blank, weighing 2,500 lb., on a gear cutting machine. No sign of porosity is apparent where the arm joins the rim. This gear blank was cast in the same manner as the gear blank shown in Fig. 2.

Figure 5 is a photograph of a large crosshead for a hydraulic press. Weight of casting, 8,000 lb. The picture shows the positions of the gates on the side of the casting, and one pressure riser on the top of the casting. The riser was of 36-in. height and 10-in. diameter, with an opening of 1½ in. for the neck of the riser, and was made with a cake core ⅜ in. thick.

Figure 6 shows a large frame housing, weighing 10,000 lb., for a rubber mill. Two risers were used on this casting. The riser placed on the foot at the right was of 36-in. height and 10-in. diameter, with a neck opening of 1½ in. The other riser, placed on the foot at the left, was of 36-in. height and 6-in. diameter, with a neck opening of one in. This casting was gated on the feet just below the risers.

Figure 7 shows a large counterweight weighing 7,000 lb. One large riser of 36-in. height and 8-in. diameter, with an opening of 1½ in. for the neck of the riser, was placed at one end and the gates at the opposite end. The mold was tilted about 6 in. at the end of the casting on which the riser was placed in order to facilitate the feeding and insure an even flow of metal in the mold.

Figures 8 and 9 show several types of small castings of approximately 300 to 500 lb. each, which can be cast with the pressure-fed type of riser.

Figure 10 shows two chills, weighing 5,800 lb. each, which are used in making chill rolls, and the bore in these castings has to be free from any signs of porosity. On the casting on the right, a narrow-neck riser of 36-in. height and 12-in. diameter and with a neck opening of 1¾ in. was used. A screen-type riser of the same size and having ½-in. diameter holes in the cake core was used for the casting on the left. Good results were obtained from the use of both of these risers, but in checking the results of a group of these castings it was found that the screen type proved to be more efficient.

Sound Castings

Figure 11 shows one of the chills (Fig. 10) machined and ready for use. The soundness of this casting illustrates the excellent results obtained by the use of these risers.

Figure 12 is a photograph of a large flywheel for a diesel engine. This casting weighs 5,600 lb., has a rim section 13 in. wide and 8½ in. thick, a plate in the center 3 in. thick, and must be perfect as far as soundness and balance are con-

Fig. 12 (left)—Large flywheel casting, weight, 5,600 lb. Fig. 13 (right)—Flywheel casting with riser broken off. Note clean break and little cleaning necessary. Fig. 14 (inset)—Flywheel casting after rough machining and ready for normalizing. White lines indicate position of riser before removal. This section of casting is shown to be entirely sound.

cerned as, when in use, it revolves at the rate of 700 to 900 rpm. In casting this flywheel, a screen-type riser 40 in. high, 18 in. wide and 8½ in. thick and weighing 1,600 lb. was used. The amount of iron fed from the riser to the casting was 240 lb., or approximately 4.5 per cent of the weight of the flywheel.

This casting was poured at a temperature of 2500° F. with a time lapse of 3 min. before the riser was filled with hot metal. The temperature of the metal for the riser was 2700° F. This was cast with high strength iron having a tensile strength of 52,000 psi.

Figure 13 shows the riser broken off the casting and demonstrates the efficiency of this type of riser in that the break is clean and little cleaning has to be done to dress the casting ready for the machine shop. The cake core used in making the screen-type pressure riser used on this casting is also shown.

Figure 14 is a photograph of the flywheel (Fig. 12) after having been rough machined and ready for normalizing. Two white lines have been drawn on this photograph to indicate the position of the riser before being removed, and it will be noted that this portion is absolutely sound.

Figure 15 shows a group of molds, one of which has just been poured. The cores at the extreme right of the picture are those used in the casting shown in Fig. 4.

Fig. 15—Group of molds, one of which has just been poured. Cores shown at extreme right are used in the casting shown in Fig. 4.

Comparison of Riser Types

The advantages of the pressure-fed type of riser as compared to the old type may be summed up as follows:

1. The castings can be fed more evenly than with the old type of riser.

2. Improvement in the casting yield, which in the case of gear blank (Fig. 2) was 50 per cent greater than when cast by the old method.

3. Manpower saving due to the reduction in the cleaning, chipping and grinding in the cleaning room, which is approximately 30 per cent less than required for the old method, and the elimination of all hand feeding as mentioned in the introduction.

Acknowledgment

In conclusion, the author wishes to thank Herbert J. Lawson, of the Dominion Engineering Works Ltd., for the photographic work done in connection with this paper.

MICHIGAN HOLDS
Area Foundry Meeting at State College

PARTICIPATING IN the Annual Regional Foundry Conference held at the R. E. Olds Hall of Engineering, Michigan State College, East Lansing, Mich., April 5-6, the Saginaw Valley, Detroit, Western Michigan and Michiana A. F. A. chapters, national A. F. A. leaders, and members of the college faculty presented a diversified program* in foundry technology at the technical sessions of the highly successful two-day meeting.

At the initial meeting of Friday morning, April 5, with Michiana chapter Director M. F. Surls, Clark Equipment Co., Buchanan, Mich., presiding, Dr. C. C. DeWitt, head of chemistry and metallurgical engineering, Michigan State College, delivered the address of welcome to the delegates.

Chairman at the conference dinner meeting of Friday evening was Prof. L. C. Price, Michigan State College. Presiding at the remaining sessions were: Friday afternoon, J. F. Smith, Chevrolet Gray Iron Div., General Motors Corp., Saginaw, Mich., Chairman, Saginaw Valley A. F. A. chapter; Saturday morning, E. C. Hoenicke, Eaton Mfg. Co., Detroit, Chairman, Detroit chapter; and, Saturday afternoon, J. W. Lee, Challenge Machinery Co., Grand Haven, Mich., Chairman, Western Michigan chapter.

Emphasizing the importance of good housekeeping in the foundry, a fair wage scale and various methods of improving the attitude of the foundry worker toward his job, A. F. A. National President F. J. Walls, International Nickel Co., Detroit, discussed "Attracting and Holding Foundry Workers" before the opening session Saturday.

Discussion Highlights

Following Mr. Walls' address, H. B. Dirks, dean of engineering, Michigan State College, expressed his views as to the type of college education desirable for young men entering the foundry industry; and outlined courses of study available at the engineering school to students preparing for a foundry career.

Concluding the Saturday morning sessions, M. E. Brooks, Dow Chemical Co., Bay City, Mich., had as his topic "The Casting of Magnesium Base Alloys." Mr. Brooks, member Executive Committee, A.F.A. Aluminum and Magnesium Division, covered problems in sand casting the light alloys, and considered the role of inhibitors and gating and riser design among other vital aspects.

At the first technical session, following the welcoming address of Dr. DeWitt, Friday morning, foundry control methods were featured in the remarks of H. W. Dietert, H. W. Dietert Co., Detroit. Mr. Dietert, member Executive Committee and active in other groups within the A.F.A. Foundry Sand Research Project, discussed such common methods as sand control, and analytical control of metal.

A technical paper on cupola fluxes which had previously appeared in AMERICAN FOUNDRYMAN (October, 1945), was presented Friday afternoon by the authors, Professor Howard Womochel and Associate Professor C. C. Sigerfoos, Michigan State College.

Other discussions commanding interest of the delegates Friday afternoon were: description of mechanical developments and other aspects in malleable iron production, by a member of the Executive Committee, Malleable Division, A.F.A. Gold Medalist C. F. Joseph, Saginaw Malleable Iron Div., General Motors Corp., Saginaw; and suggestions for application of various types of special risers to combat shrinkage problems in steel castings, among other aspects of steel casting defects covered by H. F. Taylor, Massachusetts Institute of Technology, Cambridge, Mass., who is prominent in numerous A.F.A. national activities.

*Listed, page 79, American Foundryman, March, 1946.

Foundry Publications

TWO INTERESTING ADDITIONS to the field of international technical literature, *la Fonderie Belge,* official bulletin of the Association Technique de Fonderie de Belgique, Liege, and *ABM,* bulletin of the Associacão Brasileira de Metais, São Paulo, Brazil, the latter sent with the personal compliments of Miguel Siegel, president of the Association, have been received at the A.F.A. National Office. Both are first issues.

Reflects A.F.A. Activity

Indication of world-wide interest in the A.F.A. Golden Jubilee Convention at Cleveland, is found in a write-up in the Belgian publication, which announces the Congress, discusses plans of European foundrymen to attend and provides information regarding registration and travel arrangements for those interested in participating.

Crowds throng through the exhibit hall at the Chicago Production Show and Conference recently held at the Stevens Hotel under auspices of the Chicago Technical Societies Council. Chicago A.F.A. chapter, a member organization, sponsored 15 technical sessions, more than any other participating group.

AMERICAN FOUNDRYMAN TAKES A BOW TO MEMBERS

When the February issue of American Foundryman went into the mails as completely redesigned by Roy Barfuss, a questionnaire headed "Information Please!" was sent all members in the United States and Canada, asking for comment on salient points of the magazine's current style and character. In the hundreds of replies received, the A.F.A. membership has voiced complete approval of their magazine.

Because so many men went out of their way to give the publishers praise, comments and worthwhile suggestions, A.F.A. now presents on these two pages a cross-section of how the members look at the American Foundryman. Under each of the questions asked in the questionnaire, the replies were analyzed and some of the typical answers quoted verbatim. In addition, everyone who returned a questionnaire will receive a more detailed analysis of the excellent response.

Q. No. 1—Do you like the new style of American Foundryman?

To this question nearly 99 per cent of the members who replied voted an overwhelming YES. Their replies left no doubt in the minds of A.F.A. that the readers heartily approved the new style of their magazine as designed by Roy Barfuss, a recognized typographic designer. Such comments as "fine," "definite," "excellent," "grand" and "great improvement" were appended in many cases to the affirmative answers received.

Typical of the replies were the following:
"Distinctive and dignified."
"Decidely so, it is a tremendous improvement."
"It has eye appeal."

Q. No. 2—Do you like the idea of keeping the editorial and advertising pages separate?

On this question, too, the members were emphatic in their expressions of approval for over 90 per cent replied YES.

This affirmative ballot was not only gratifying but is especially interesting in view of the fact that it confirms the policy of A.F.A. when the format of American Foundryman was first decided. As a technical society obligation of presenting information of value to the industry in the most readable form, the Association adopted the present form of editorial makeup in the belief that this form would be preferred from the standpoint of reader interest. It is gratifying to know that the membership approves this step, and that the readers of American Foundryman appreciate the "break" given them by keeping the editorial and advertising pages separate.

Typical of the comments on this policy were:
"Excellent."
"Decidely yes."
"Great if you wish to have future copies bound."
"It is one of the good features."

Q. No. 3—Do you like the idea of running each main article consecutively complete, i.e., without carry-over to the back of the book?

Here again the membership rose in a body of nearly 90 per cent to vote a loud YES . . . even though in doing so they flew in the face of considerable publishing tradition.

When A.F.A. decided to run each technical and practical article consecutively complete, it realized that this policy might be subject to considerable argument, yet it was felt that the editorial policy was sound, again from a reader standpoint. Thanks to the interest taken in American Foundryman by the Association membership as a whole, A.F.A. now knows that its readers approve the present style with regard to main articles.

Foundrymen Know What They Want

It is quite evident that foundrymen know what they want and do not hesitate to say what they like. On Question No. 3, the great majority have indicated that they want their main articles "straight" without having to jump back and forth in order to get the "meat" out of their reading. Thus their vote is a virtual mandate for American Foundryman to "give the reader what he wants."

Typical of the replies on this question were:
"Yes, definitely."
"Easy filing of issues."
"Less distracting to continuous reading of one article."

Q. No. 4—Would you like to see more theoretical? . . . more technical? . . . or more practical? . . . articles (check which) run in American Foundryman.

It has long been the policy of American Foundryman, since its establishment in 1938, to strike a balance between the technical, the theoretical and the practical in its editorial pages. However, with the constantly growing membership, now over 8,000, A.F.A. felt that the readers themselves should decide the future editorial policy of their own magazine.

Replies to this question showed that the great majority wanted to see more practical articles appear in their magazine . . . over 57 per cent. Over 30 per cent of the replies expressed a desire for more technical material and some 13 per cent requested articles of a more theoretical nature, especially dealing with basic engineering principles and operational formulæ.

It is interesting to know that one member asked for an even balance on all three types of articles. Quite a a few said that they favored the present proportion now

planned for AMERICAN FOUNDRYMAN. Other interesting replies, typical of most, were as follows:

"More practical articles, of course. After all you want to reach the man in the shop."

"The practical always seems to have greater value to the average reader."

Q. No. 5—Briefly, in what respect have the articles in AMERICAN FOUNDRYMAN proved of real value to you in your work?

An editor usually works in the dark. His opportunities for sounding out the value of his work to his "audience" is necessarily confined to a few individuals, usually in high places, and to obtain a cross-section of reader interest, he usually must estimate or guess.

Many and detailed replies to Question No. 5 indicate that the AMERICAN FOUNDRYMAN is proving of real value to members in many ways. A great many replies stated in effect that the magazine helps them to "keep abreast of developments in the foundry industry." Quite a few are finding the magazine "very educational." A considerable number stated that the greatest value to be found in its use as a check against their own current practices, by stimulating thought and a desire for improvement.

Typical of the scores of replies as to how AMERICAN FOUNDRYMAN has increased the "know how" of its readers were the following comments:

"The discussions on foundry sand and sand reclamation have been most helpful."

"Where the data appears reliable we utilize the information to improve the quality or reduce the cost of casting manufacture."

"Some of the information has been applied directly. Others have suggested new ideas or new approaches to old problems."

"Your section on abstracts is of unlimited value."

Q. No. 6—Do you have any suggestions (or even criticism) to make your magazine better serve your needs?

In asking this frank question of the membership, the Association fully expected that the great divergence of opinion in the foundry industry might well prove helpful in publishing a better magazine. Over 50 per cent of all the members who replied took the time and trouble to answer this question and to comment on how their magazine pleases them, or how they felt it could be improved still further. Some of the replies, surprisingly enough, dealt with technical editorial points and were well taken. Others as might be expected urged more articles in their particular fields of activity.

The amazing thing about the tremendous response to Question No. 6 lies in the many excellent suggestions for improvement of AMERICAN FOUNDRYMAN, even though most of the suggestions were prefaced by praise. Quite a number expressed the desire for more pictures, and it can be stated that as an editorial policy AMERICAN FOUNDRYMAN agrees with such comments wholeheartedly. Numerous readers urged that more attention be given the beginner and apprentice, so that the future manpower in the industry may become better trained through reading good material. Some asked for more information of the "Question and Answer" type; some asked for larger, more concise articles; some asked that particular sections be set up and devoted to the various branches of the industry. All responses indicate that the members of A.F.A. are taking a definite interest in the progress of their magazine, and want to see it continue to grow and improve.

As might be expected after such a recent change, a few of the older members expressed regret that the quarterly TRANSACTIONS is no longer being published. Overwhelmingly, however, the great majority of member replies indicated complete approval with the current policy of publishing AMERICAN FOUNDRYMAN, followed by the annual TRANSACTIONS at the close of the year.

Typical comments on Question No. 6 are shown below, mainly to give some idea of the complexity of interest that must be served in specifying the reading needs of the Association's steadily increasing membership:

"I would appreciate more material on steel, especially on high manganese steels."

"I would like to see more articles dealing with the metallurgy of gray iron and less on foundry management—(such as making better foreman, etc.)."

"How about an occasional article pertaining to the economics of the foundry industry."

"Cite more practical training and industrial relations programs that are in operation."

"We are interested in material on induction melting. Articles on this subject are very few."

"We would like to see more articles on the finishing (cleaning, grinding and straightening) and inspection of castings. I think this part of the foundry industry has been neglected in the past."

"A beginner myself, I would like to see an occasional article devoted to beginners and students."

"Sometime try presenting an article pictorially, or nearly so. Your pictures are good now, however."

"More 'end use' data; specifications of metals for various applications, especially alloys."

"How to sell management on foundry—secure more interest from employees who will not seek employment in foundry."

"As pattern shop operator would like more articles in relation to pattern equipment and new methods of molding."

"More articles on cost accounting and incentives for gray iron foundry."

"In your articles have more suggestions and methods and less direct reference to a Mr. So-and-So who refers to another Mr. So-and-So."

"The progress of the publication has been so great and so rapid since its institution that criticism from anyone seems out of place. Personally, I have watched the mechanical side of the paper with ever growing interest inasmuch as the mechanical standpoint of printing has been a lifelong hobby."

Thanks for Comments!

The A.F.A. staff takes this opportunity of expressing to its members who replied to the questionnaire its sincere appreciation for their time and thought. As a result, instead of working in the dark as to the reader interest of AMERICAN FOUNDRYMAN and what the readers want, the Association now knows that it is working in the right direction in order to make the magazine of maximum value to the membership.

50 YEARS OF PROGRESS IN FOUNDRY

STEEL MELTING

A. W. Gregg
Executive Engineer
Whiting Corp.,
Harvey, Illinois

THE EARLY HISTORY of steel making is lost in the fogs and mists of antiquity, but this is not true of the manufacture of steel castings.

The great developments of the steel casting industry have taken place within the memory of men now living. However, it is to be regretted that we failed, while we still had the opportunity, to secure a record of the experiences of sturdy pioneers of the steel foundry industry—men like Harry Wright and his brother Frank Wright of the Ohio Steel Foundry; J. C. Davis and Bill Parker of American Steel Foundries; "Paddy" Carroll of the former Bucyrus Steel Foundry, Bucyrus, Ohio; Major R. A. Bull of the Electric Furnace Research Group; George Batty, and David McLain of Milwaukee, and Henry M. Lane and Thomas D. West of Cleveland . . . to name only a few.

Early Steel Making

The earliest steels were made by a combination of the cementation and crucible processes, as early as 500 A.D. in India, Syria and Spain. During the Middle Ages the crucible steel process was a lost art, but it was rediscovered in England in 1742 by Benjamin Huntsman.

Steel was made by the crucible process, or by a combination of the cementation and crucible processes, from 1742 until more than 100 years later, when William Kelly in America and Henry Bessemer in England almost simultaneously developed the pneumatic process of producing steel. The invention of the pneumatic or Bessemer process, as it is now called, is the most important event in the modern history of steel making.

There is an interesting account of the work done by Kelly and Bessemer in a book published by the U. S. Steel Corporation entitled *"Making, Shaping and Treating of Steel."*

Kelly and Bessemer both applied for a patent on the process in 1857, and the patent was granted to Kelly because he could prove that he had been working on the process since 1847. Although Kelly never perfected the process, he built the first converter in America in 1857 for the Cambria Steel Works at Johnstown, Pa., and this vessel is still preserved. A photo of this unit is shown in Fig. 1, reproduced from the *Handbook* of Steel Founders' Society of America.

Bessemer's vessels were tried out in several steel plants in England and so much trouble was encountered with the steel, because of brittleness due to improper deoxidation, that Bessemer was obliged to build his own steel plant in 1860 to demonstrate utility of his process.

A survey concerned primarily with the development of steel melting methods and equipment as applied to the steel casting industry. Some historical data pertaining to the earliest methods of making steel have been included because of their importance and connection with the history of steel foundry melting equipment.

The Siemens Open-Hearth

William Siemens, in England, in 1858 built the first open-hearth furnace employing the regenerative principle. The first open-hearth furnace to use gaseous fuel was built by Siemens in 1861, in which year he patented the design.

After several unsuccessful trials of the open-hearth furnace in various steel plants, Siemens, like Bessemer, was obliged to build his own plant at Birmingham, England. He developed basic practice, using a magnesite hearth, and was successful in reducing phosphorus and sulphur. The first steels were made from scrap, but later the pig and ore method was employed.

Siemens, who was a prolific inventor, is also given credit for the first experiments in melting steel with an electric current. In 1878 he applied two horizontal electrodes through the wall of a crucible to form an arc over the metallic charge. He successfully melted steel with this crude equipment.

At the same time that Siemens was developing the open-hearth furnace in England, the Martin brothers in France were working on a similar furnace. They developed the pig and scrap method for making steel, and open-hearth steel is made today by a combination of the methods of Siemens and the Martin brothers, the open-hearth furnace being commonly known as the Siemens-Martin furnace.

The steelmaking history discussed

thus far pertains to steels cast into ingot form for subsequent rolling and forging.

Claims conflict as to who made the first steel castings. One account claims that Jacob Meyer of the Bochum Steel Works in Westphalia, Germany, cast church bells of crucible steel in metal molds in 1851. The Vickers company in Sheffield, England, made crucible steel castings in 1861 and paid royalty for use of the Reippe patent, which covered the material of the mold for producing castings of steel. The patent describes a mixture of ground clay crucible, plumbago and tar.

Early American Steel Castings

Probably the first steel castings in America were made in 1861 by the Buffalo Steel Co., Buffalo, N. Y., now owned by Pratt & Letchworth. These were railway castings and the steel was made in crucibles. The company poured steel from a 15-ton acid open-hearth furnace as early as 1876.

The William Butcher Steel Works, near Philadelphia (now the Midvale Co.), made cast-steel railway crossing frogs in 1867, and also used the crucible process. This company installed a 3½-ton basic open-hearth furnace in 1870 and the first heat was tapped on January 2, 1871, but furnace proved unsatisfactory.

Stewart Johnson, writing for the American Foundrymen's Association annual meeting of 1898 (TRANSACTIONS, A.F.A., vol. 5, p. 142) says that the first steel foundry in America was organized by William Hainsworth in 1871 at Pittsburgh, Pa., as the Pittsburgh Steel Casting Co. The first melting unit was a 2-pot coke-fired crucible furnace, but an open-hearth furnace was installed in 1874. There is also record of a Bessemer converter being installed in 1881.

The bottom-blow Bessemer converter has never been successful for the manufacture of steel castings. In 1894 Hainsworth's company was combined with the American Casting Co. and the plant was later sold to Pittsburgh Valve Foundry Co.

The first steel castings west of Pittsburgh were made in Minneapolis in the early 1870's by Peter L. Simpson, the father of H. S. Simpson of the National Engineering Co., Chicago. The steel was melted in crucible furnaces.

One of the oldest steel foundries in America, the Isaac G. Johnson Co. of Spuyten Duyvil, N. Y., was organized originally as an iron foundry in 1852. The first steel castings were made in 1878 using coal-fired, pit-type crucible furnaces. In 1882 an 8-ton acid open-hearth furnace was installed, and in 1894 side-blow converters were purchased from Alexandre Tropenas.

In 1888 the Detroit Steel & Spring Co., Detroit—now the Detroit Steel Casting Co.—imported two 2-ton Robert-Bessemer converters from France. These were side-blow vessels similar to the Tropenas converter and were used for the manufacture of castings. The Robert converter had a single row of tuyeres, in which respect it differed from the earliest Tropenas converters which were operated with two rows of tuyeres.

Evolution of Melting Methods

The development or evolution of melting methods and equipment in the steel foundries in this country in general has been as follows:

The crucible furnace had the field entirely to itself from about 1860 to 1870. The open-hearth furnace came into the picture in 1870, and metal for steel castings was made with the crucible furnace and the open-hearth furnace from 1870 until the early 1890's (Fig. 2).

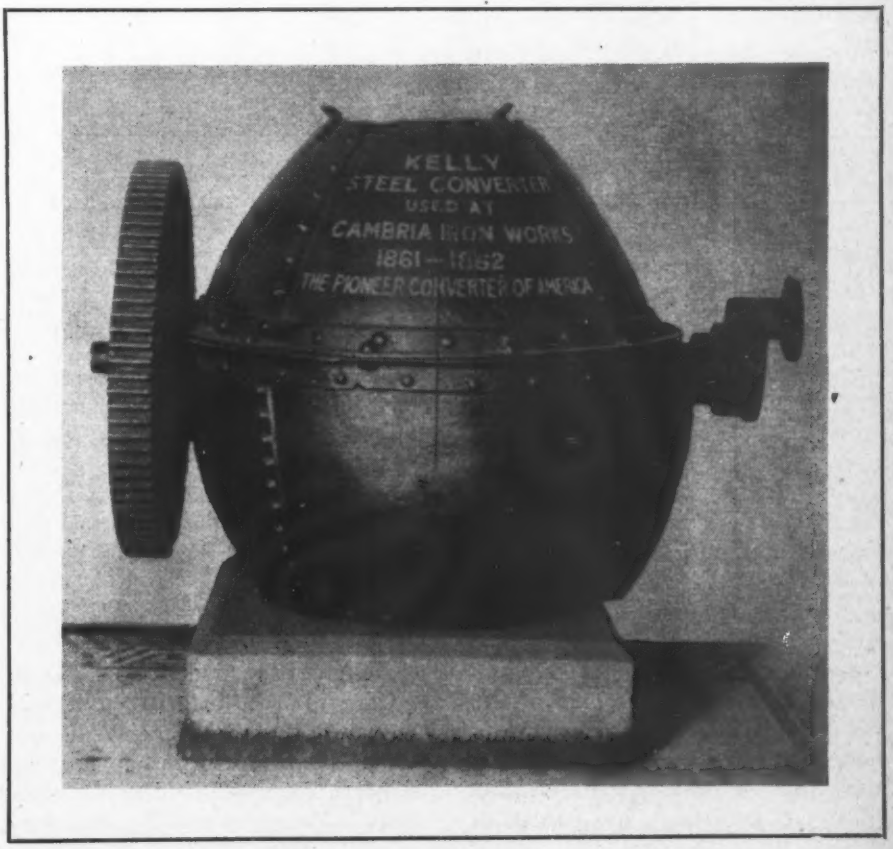
When the side-blow converter was introduced into the United States about 1890, the crucible process began to lose favor for the production of small and medium-weight castings. From about 1895 until 1917 or 1918, the open-hearth furnace and the side-blow converter made practically all of the steel castings manufactured in the United States.

Rise of Open-Hearth Steel

In 1904 the combined figure for the tonnage of castings produced by the open-hearth and converter processes was 98.4 per cent of the total castings manufactured. In 1909 the corresponding figure was 97.8 per cent; in 1914 it was 97.5 per cent, and in 1919 it was 91.3 per cent.

The open-hearth furnace has never lost its place for the production of heavy castings and large tonnages. The first open-hearth furnaces used for castings were all operated with acid bottom. At the beginning of the century at least 80 per cent of all open-hearth steel castings were made from metal produced in acid-lined

Fig. 1—The original Kelly converter, the first converter used in America. This furnace still is preserved.



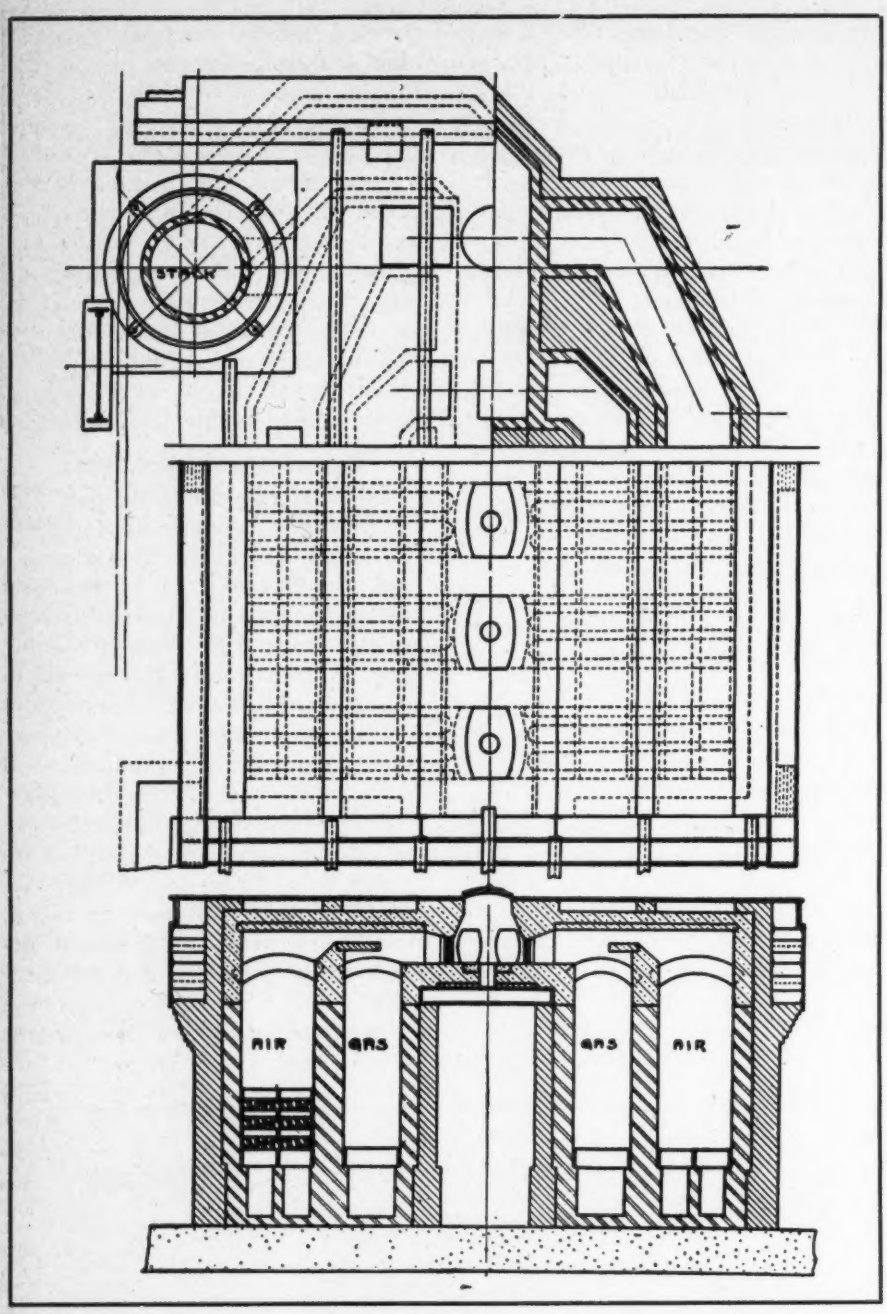


Fig. 2—Diagrammatic sketch of crucible regenerative furnace taken from "Making, Shaping and Treating of Steel," published by U. S. Steel Corp.

furnaces. Production today of open-hearth castings is about evenly divided between acid and basic furnaces.

The electric furnace received its big start in America during World War I, and since 1916 the output of electric steel for commercial castings has steadily increased. The electric furnace was the last process to come into general use for the production of steel castings, and in 1943 the output of electric steel for commercial castings was actually greater than that of open-hearth furnaces.

In the meantime, the output of converter steel steadily declined and reached its lowest point about 1939. Figures published by the Department of Commerce show a production of converter steel in that year of 2592 tons, while electric steel production is reported as 245,223 tons (Table 1).

The Open-Hearth Furnace

Design of the modern open-hearth furnace includes such improved features as the sloping back-wall, and water cooling for critical parts such as ports, skew backs, doors and door jambs. Design of checker chambers and slag pockets has been much improved, and insulation for various parts of the furnace has reduced fuel consumption.

The manufacturers of refractory materials have greatly improved their product year by year, and this is especially true of basic refractories. The practice of sintering bottom material layer by layer is being replaced by the method of ramming in place a monolithic bottom, resulting in longer life for walls and roofs, and a saving in fuel.

Manufacturers of refractory material are now developing magnesite brick with sufficient mechanical hot strength to permit use in arches. Some companies even now are experimenting with open-hearth furnace roofs composed entirely of magnesite brick. Some of the larger furnaces have forced draft and waste-heat boilers.

The improvements mentioned have increased production and reduced maintenance costs, but it must be admitted that the open-hearth furnace in use today is essentially the same as the furnaces used fifty years ago.

Control Greatly Improved

The greatest improvements in the operation of the present-day furnace must be credited largely to improved control equipment, which has largely eliminated the need for skill and long training periods for open-hearth furnace operators. Fifty years ago it was necessary for a man to spend many years on an open-hearth platform before he was felt competent to operate the furnace, and the melter's most important control equipment was a pair of blue glasses.

Carbon composition of the bath was determined by examining the fracture of a test piece. An occasional preliminary analysis was made by the laboratory, and the time required was about 15 to 20 minutes. Preliminary carbon determinations were made in the laboratory by the rather inaccurate color comparison method.

Today the carbometer or the carbo-analyzer make it possible to determine carbon with accuracy within two to three minutes from the time a test sample is dipped from the furnace. Most laboratories now have high-temperature combustion furnaces for the determination of carbon and can report accurate

results to the furnaceman in from 5 to 7 minutes. Some laboratories are even equipped with spectroscopic equipment for the rapid determination of all elements except carbon and sulphur.

Temperature Control

Determination of the temperature of the bath and the proper combustion of the fuel was entirely visual in the old days, as was also control of the composition and fluidity of the slag. Reversal of the flow of fuel and air was accomplished by manual operation of the reversing levers, dependent to a great extent on the melter's judgment of the temperature of the roof and of the bath. Today many open-hearth furnaces have pyrometer-controlled equipment which automatically reverses the flow of fuel and air, dependent upon the temperature of the checker chambers.

Pyrometer equipment located in the furnace roof gives a warning when the temperature is dangerously high. Fuel and air are automatically proportioned for proper combustion. Metal temperatures now are checked with optical pyrometers, whereas the old-time melter determined temperature by pouring numerous spoon tests on the floor. Another method was to dip a rod in the bath and swish it back and forth in the metal; the extent and nature of the cut on the rod gave a fairly good indication of the temperature of the bath. Still another method of determining temperature, still used today, was to measure the time required for a film to form over a sample of metal held in a test spoon.

Table 2

PRODUCTION OF STEEL CASTINGS
BY CLASSES AND BY MELTING PROCESSES
AS REPORTED BY 228 COMMERCIAL* STEEL FOUNDRIES FOR THE YEAR 1943

	Net Tons					
Class of Castings	*Open Hearth*	*Electric*	*Converter*	*Crucible*	*Induction*	*Total*
Carbon Steel.....	727,252	704,550	25,064	317	460	1,457,643
Low Alloy Steel....	67,495	116,231	237	.....	253	184,216
High Alloy.....	83	15,264	.....	.....	3,828	19,175
High Manganese..	.....	44,998	.....	.....	.....	44,998
ALL CLASSES....	794,830	881,043	25,301	317	4,541	1,706,032

SOURCE: Special Survey by Steel Founders' Society of America.
*Does not include captive foundries.

Changes in Fuels

The most popular fuel used today is oil, or natural gas where available. Experiments have been made with powdered coal and some day this may be of vital interest. Powdered coal is an ideal and economical fuel and the sole objection to its use is based on the accumulation of fly-ash in slag pockets and checker chambers.

The National Malleable & Steel Castings Co. operated an open-hearth furnace at Sharon, Pa., with powdered coal for about twenty years, and also experimented with powdered coal at Melrose Park, Ill. However, the powdered fuel was finally abandoned and the furnaces equipped to burn oil.

Unless new oil fields are developed in the future, powdered coal as a fuel for open-hearth furnaces again may be an important subject for investigation. The present design of slag pockets and checker chambers will require radical changes, or it may be necessary to use a recuperative system to preheat the air.

Acid and Basic Operations

As previously noted, the early open-hearth furnaces were all operated with acid bottoms, but since about 1909 there has been a great increase in basic operation for the open-hearth furnaces used in the production of steel castings. Today the production of steel by open-hearth furnaces is about evenly divided between acid and basic operation.

W. W. Coleman of the Bucyrus-Erie Co., when he was assistant open-hearth superintendent for the Bethlehem Steel Co., made intensive studies of basic and acid steel in 1895 and became convinced that basic steel, if properly made, is inherently better than acid steel. Prior to his time at Bethlehem, all castings were made of acid open-hearth steel. Mr. Coleman, when open-hearth superintendent at the Latrobe Steel & Coupler Co., Melrose Park, Ill., changed the two 30-ton open-hearth furnaces from acid to basic operation in January, 1904, which accomplished a reduction in cost together with an improvement in steel quality.

In 1909 open-hearth furnaces produced 91½ per cent of all the steel used for castings. Twenty years later, open-hearth's share of produc-

Table 1

PRODUCTION OF STEEL CASTINGS
BY PROCESS OF MANUFACTURE, 1899-1939
(Net Tons)

Census Year	*Total Tonnage*	*Open Hearth Tonnage*			*Electric and Crucible*	*Converter*
		Total	*Basic*	*Acid*		
1899.....	198,414	185,392	40,907	144,486	8,810	4,212
1904.....	326,490	304,641	100,432	204,210	5,691	16,158
1909.....	615,143	562,905	300,443	262,462	13,637	38,601
1914.....	659,334	593,542	337,351	256,191	17,143	48,649
1919.....	825,485	701,923	297,211	404,712	72,463	51,099
1921.....	464,762	380,595	197,040	183,555	53,794	30,373
1923.....	1,254,410	1,041,834	499,322	542,512	170,474	42,102
1925.....	1,128,863	896,927	462,559	434,368	196,380	35,556
1927.....	1,100,907	836,286	390,967	445,319	235,614	29,007
1929.....	1,531,040	1,166,082	586,525	579,557	349,672	15,286
1931.....	514,417	355,637	136,399	219,238	150,331	8,449
1933.....	312,225	208,215	81,198	127,017	101,413	2,597
1935.....	575,398	357,258	131,611	225,646	213,369	4,771
1937.....	1,315,837*	959,346	542,970	416,376	337,360	9,068
1939.....	613,719	365,904	211,123	154,781	245,223	2,592

SOURCE: Census of Manufactures, Department of Commerce, Bureau of Census.
*Includes 5,032 net tons of steel castings which are not reported by kind.
NOTE: Original statistical series were published in terms of gross tons (2240 lb.) but have been converted to net tons in above table.

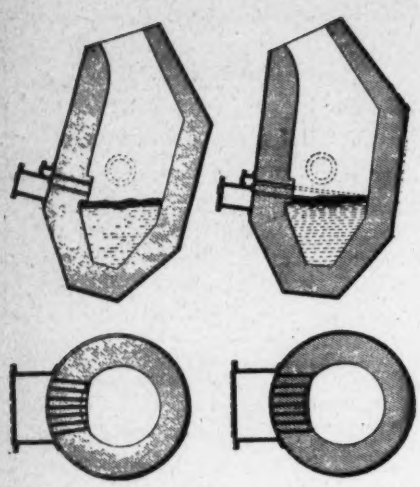


Fig. 3—Early Tropenas Converter as reproduced in A.F.A. Transactions of 1898, a type widely sold throughout Europe to 1900.

tion had decreased to 76.1 per cent of the total, and in 1943 the figure was 46.6 per cent of the total (Table 2).

The Side-Blow Converter

The first Tropenas side-blow converter to make steel for castings in America was at the George H. Smith Steel Casting Co., Milwaukee, and was installed in April, 1899. Other early Tropenas converter installations were: Union Iron Works, San Francisco, in November, 1899; B. A. Kelly Plow Co., Longview, Texas, in December, 1899; Driggs Seabury Gun & Ammunition Co., Derby, Conn., in 1900; Logan Mfg. Co., Phoenixville, Pa., in 1900; and American Hoist & Derrick Co., St. Paul, Minn., in 1900.

Arthur Simonson, now of the Falk Corp., Milwaukee, whose first job was with the Edgar Allen Steel Co., Sheffield, England, came to the United States in early 1900 to represent the Tropenas Company of France. In June, 1901, he installed a 3-ton side-blow converter at the plant of William Wharton, Jr., in Philadelphia, which plant was later absorbed by the Taylor-Wharton Iron & Steel Co. of High Bridge, N. J. Mr. Simonson remained with the Wharton company as general superintendent until 1906, when he left to go into partnership with Alexandre Tropenas to found the Tropenas Steel Co. at New Castle, Dela. This plant is now owned and operated by the American Manganese Steel Division, American Brake Shoe Company, New York.

A very interesting article by Alexandre Tropenas was published in the 1898 TRANSACTIONS of American Foundrymen's Association (vol. 5, p. 118), in which the author lists 34 converters scattered throughout Europe, in France, Belgium, Russia, Poland, Australia and England, including three 2-ton vessels at the Royal Woolwich Arsenal. A picture of the Tropenas converter of these early days is reproduced in Fig. 3, taken from a cut in TRANSACTIONS of A.F.A. (vol. 5, p. 118).

Converter Steel

When the converter process began to replace the crucible process in the early 1890's, it was because of its lower operating cost and its ability to produce high-temperature steel in large quantities. At one time there were about 50 foundries in America making steel castings with the side-blow converter (Fig. 4).

Converter steel can be produced at very high temperatures, making it possible to pour castings having extremely light sections. Also, because of the speed of operation, it is possible to combine several blows for the manufacture of a large casting. Two and one-half to three blows per hour can be produced with converters ranging from one to three tons capacity. The pearlitic and sorbitic alloys in general use for castings can be readily produced with the converter.

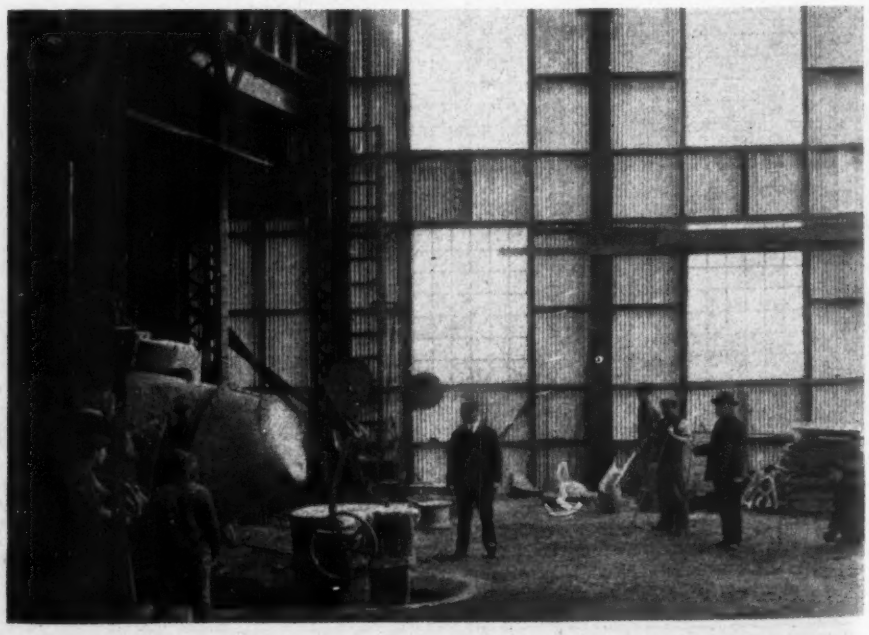
A few important producers of castings have always used the converter process, among whom can be mentioned the Link-Belt Co. of Chicago, whose converters were installed in 1907 and have been in regular operation since then. Under the management of Fred B. Skeates, this foundry has built a reputation for the quality of its castings. The American Hoist & Derrick Co., St. Paul, is another foundry which has operated converters continuously since 1900.

Recovery of the Converter

The high sulphur content of converter steel had more to do with its loss of popularity than any other single factor. Desulphurizing practice was developed about 1920, for which George S. Evans of Griffin Wheel Co. and Mathieson Alkali Works was largely responsible. Desulphurizing came too late to enable converter steel to meet the sulphur requirements for ordnance castings during the first World War.

Converter operation today has been greatly simplified and improved by the introduction of the electronic flame-control equipment, developed by H. W. Graham and Dr. Harold K. Work of Jones & Laughlin Steel

Fig. 4—Reproduction of an early Whiting converter installed at the Vancouver Engineering Works, Vancouver, B. C., Canada, as illustrated in an early catalog.



Corp. about 1939. This equipment prevents over-blowing by catching the end point of the blow more accurately than is possible with the human eye. It also has materially reduced blowing loss by indicating when a boil is about to occur, thus enabling the operator to reduce blast pressure.

The Jones & Laughlin Steel Corp. has also developed a new design of side-blow converter which is said to give better refractory life, lower blowing loss and greater flexibility as to capacity than the orthodox side-blow converter. To date, this design has not been announced to the trade.

Development of Triplexing

The cupola, converter and electric furnace have been combined into a melting, refining and distributing unit, making it possible to produce steel continuously to supply a moving mold conveyor. This method of producing steel has been called triplexing, and has great possibilities for continuous high capacity production of steel. In one foundry, as much as 340 tons of molten steel have been produced with this process in a 16-hour period, supplying metal for a continuous molding unit where molds were poured at a rate of five to six per minute.

In spite of many converter advantages, the electric furnace has practically replaced the converter for the manufacture of small steel castings. However, during the last five years, interest has been revived in the converter and some 50 new converters have been purchased by the foundry industry. Further research work on converter operation, and especially on its possibilities for basic operation, may result in new interest in this process. The converter process has never had the benefit of the intensive research investigations given to the open-hearth and electric furnace processes (Fig. 5).

Fig. 5—Recent type steel converter manufactured by Whiting Corp.

As mentioned before, Siemens was experimenting with electric arc melting as early as 1878, but the first successful arc furnace for melting steel was placed in operation by Heroult in France in 1899. Heroult's patent covered single or multiple-phase furnaces with arcs in series.

The Electric Furnace

The first electric furnace in America was a single-phase Heroult furnace of 4-ton capacity, which was installed at the Halcomb plant of the Crucible Steel Co. of America at Syracuse, N. Y., in 1906, and the first heat from this furnace was tapped on April 4 of that year. The shell of the furnace was shipped to America from France and the furnace is now in the front yard of the Halcomb Steel Co. at Syracuse. A photograph of this furnace is reproduced in Fig. 6 from the letterhead of the Halcomb company. In 1908 a similar but smaller Heroult furnace was installed at the Firth-Sterling Steel Co., McKeesport, Pa.

T. S. Quinn of the Lebanon Steel Foundry informs us that the first 3-phase furnace he ever heard of was at the plant of the American Steel & Wire Co., at Worcester, Mass. This was a Heroult furnace and was originally operated with a basic lining. Later acid operation was tried, but with indifferent success. The furnace was installed early in 1910 and we have a record of steel and slag analyses made at Worcester on March 9, 1910. The heat number was 9,264 and the analysis of the slag indicates that the furnace was operating with a basic lining. Basic operation was continued at least through the first half of 1912.

In 1909 a 15-ton Heroult furnace

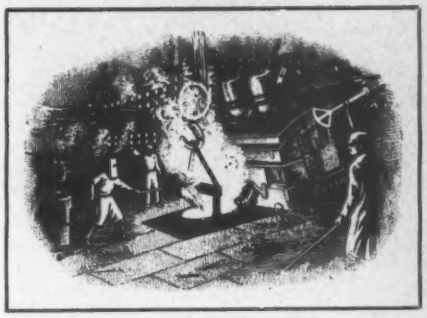


Fig. 6—Steel plate engraving of the Halcomb Electric Furnace, termed the "first electrically heated steel melting furnace in the U. S.," taken from a letterhead of the Halcomb Steel Co., Syracuse, N. Y.

was installed at the South Works plant of the Illinois Steel Co., South Chicago, Ill. This furnace is said to have been the first furnace to have a round shell, and it was the first which could properly be called a large furnace. (One source, however, claims these "firsts" for a furnace of the same size installed in Worcester, Mass., about the same time.) The Illinois Steel furnace was operated with basic lining and the transformer was 1145 kva. capacity.

General Electric Furnace

The General Electric Co. built an electric furnace of its own design at Schenectady, N. Y., late in 1910. This furnace is of interest because of its connection with the electric furnace installed at the Treadwell Engineering Co., Easton, Pa., late in 1910, which is generally recognized as the first electric furnace to be used in a steel foundry in this country.

T. S. Quinn of the Lebanon Steel Foundry was, at that time, Superintendent of Foundries for the Treadwell Engineering Co., and the following is quoted from an interesting letter from Mr. Quinn:

"The time of which I am speaking was late 1910 or early 1911. In that year Treadwell built a new plant at Easton and I became their first Superintendent of Foundries. Treadwell sent me to see the General Electric installation, and by some agreement between General Electric and Treadwell, Treadwell procured drawings of the General Electric furnace and had a furnace built for them.

"This furnace was given to me to

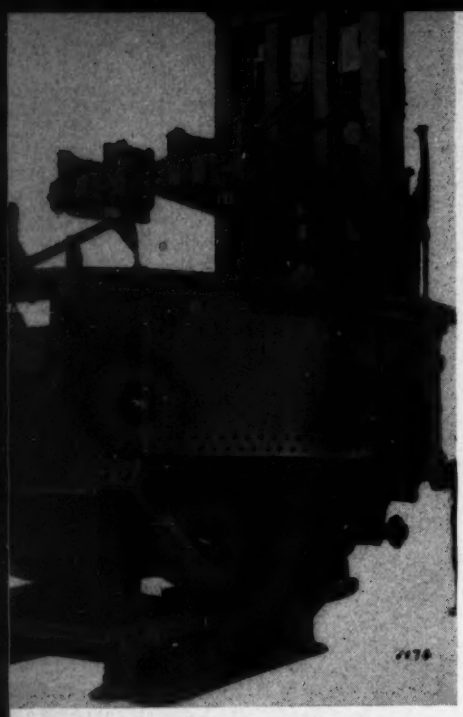


Fig. 7—One of the earliest Heroult furnaces of 6-ton capacity built by Whiting Corp.; installed in the American Steel Foundries plant at East Chicago, Indiana, late in 1915.

operate basically, and a worse furnace I cannot conceive of. The furnace was rectangular in shape and frequently, when tilting to tap, the flat back wall would fall in. The electrodes were three in number and square with no threaded joints, as they were unknown at the time. When an electrode had been used until it became a stub, and a long one at that, it was pulled out and a new one inserted.

No Regulators

"There were no automatic regulators, although I understand the Thury regulator was known in Europe. The operator stood behind the furnace at a panel and raised and lowered the electrodes as required, with make and break switches of the most inadequate design. There was a time limit inverse relay switch which, on sustained short circuits, would relieve the furnace. I actually operated this furnace for a period of four months with no help other than blood, sweat and tears."

Mr. Quinn left the Treadwell company in October, 1911, to start the Lebanon Foundry in partnership with William Worrilow. The Lebanon company, like so many other foundries, started operation with crucible furnaces but installed the first electric furnace in March, 1915. This furnace was a Heroult 3-phase of 2-ton capacity and Mr. Quinn says that it did not differ from the conventional Heroult furnace of today. Its shell was round, the electrodes were round, and the electrodes had screw joint nipples. Amorphous carbon electrodes were used.

The first furnaces at Lebanon were operated with basic lining, but they were changed to acid in 1916. The electric furnace installed in March, 1915, at the Lebanon Steel Foundry was the first definitely successful arc electric furnace to be used for the manufacture of steel castings in America.

Heroult Furnace

The writer's own company—the Whiting Corporation—built one of the earliest Heroult furnaces, a 6-ton capacity, for the American Steel Foundries in the latter part of 1915, as a sub-contractor for the American Bridge Company (Fig. 7).

The first American-designed electric furnace was the Snyder, a single-phase furnace having a water-cooled bottom electrode and a copper shell. It was designed by F. T. Snyder and first operated in September, 1911. An installation of this interesting unit may be seen in the accompanying illustration (Fig. 8).

The Snyder furnace was installed in several different foundries, among them the Sivyer Steel Casting Co. at Milwaukee; the Gerlinger Steel Casting Co. at Milwaukee; the Thomas Davidson Mfg. Co., Montreal, Canada; the Dayton Steel Foundry, Dayton, Ohio; and the Crucible Steel Casting Co. at Milwaukee. An interesting article discussing the operation of the Snyder furnace was published in vol. 25 (1916) of the A.F.A. TRANSACTIONS, written by F. J. Ryan, E. E. McKee and W. D. Walker.

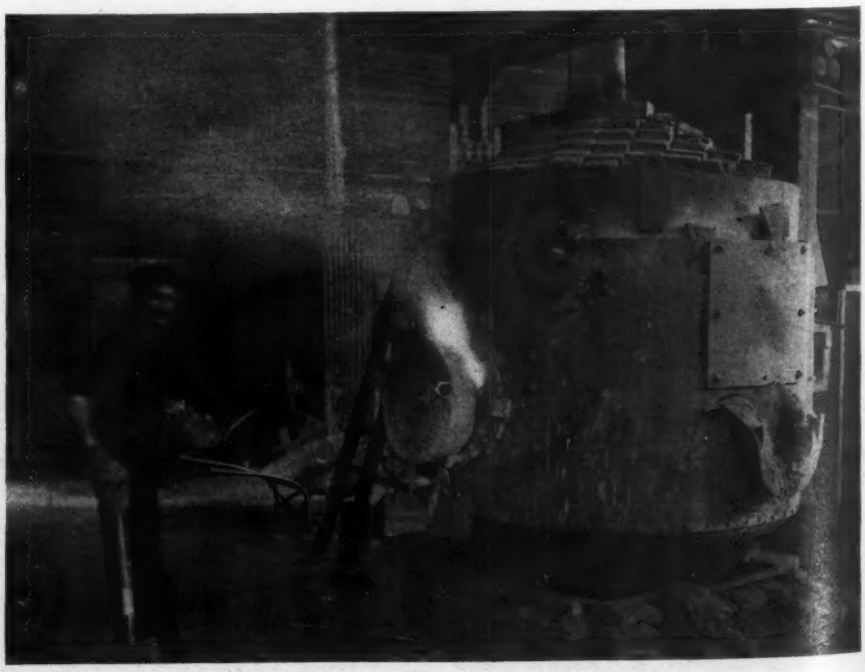
Early electric furnaces were crude affairs, operated with hand-control for positioning the electrodes and subject to high refractory and electrode cost because of the design of the furnace and the inferior quality of the refractory materials available to engineers at that time, and therefore used in construction of the unit. Electrodes also were of the most unsatisfactory quality.

Design Improved

From 1920 until the present, the design of electric furnaces has been greatly improved. Introduction of the removable roof to permit top charging has greatly increased output by shortening the time between heats, and has also contributed largely to decreased power consumption. The first furnace to employ this type of construction was a 6-ton Lectromelt furnace installed at the Bethlehem Steel Co., Bethlehem, Pa., in 1925.

Probably the greatest improvement in electric furnace operation

Fig. 8—The Snyder Electric Furnace, the first American designed electric furnace, installed at the plant of Sivyer Steel Casting Co., Milwaukee.



was brought about by introduction of automatic control equipment for positioning the electrodes, thus making it possible to hold a steady power input. The first automatic regulator was the Thury, which came to the United States in 1910 or 1911. It was introduced by the Volta Mfg. Co. of Canada, and the first installation was on a carbide furnace at Buffalo. This instrument was mechanically operated.

The Wisconsin Electric Power Co. built an automatic contact-making ammeter-type regulator for a 3-phase furnace in 1917. In 1917 the General Electric Co. developed a similar regulator which was installed on a Moore furnace at the Sivyer Steel Casting Co., Milwaukee, by the Wisconsin Electric Power Co. In 1922 the Westinghouse company brought out an improved regulator of the contactor type, having both potential and current coils.

Automatic Equipment Improves

Year-by-year improvement in automatic regulator equipment has resulted from competition between the large manufacturers of electrical equipment. The most popular control equipment, at the present time, is the rotating type marketed under three different trade names by General Electric, Westinghouse and Allis-Chalmers.

This equipment is a generator-amplifying combination, in which rectified-electrode-arc current is balanced against rectified-arc potential, in the field of a small generator for each phase. If arc-current flow is too high, the generator puts out electrode motor current in one direction. If arc-voltage is too high, the generator puts out electrode motor current in the opposite direction. The current output is always in proportion to the degree of arc off-balance for either raising or lowering the electrode.

About three years ago a new type regulator was developed, based on electronic control. This regulator has no moving parts and can respond electrically in a fraction of a cycle, provided the furnace mechanical parts can handle such a fast response without hunting and overheating. Only one installation of electronic control equipment has been made to date, so far as is known (Fig. 9).

Two classes of mechanical electrode positioning equipment are in current use in America today:

(1) A motor winch steel cable drive wherein a steel cable is directly attached to a motor winch drum, or a steel cable counterbalanced drive.

(2) Hydraulic control is a recent development, extremely fast and accurate. The weight of the electrode arm and moving parts is counterbalanced with air pressure. By counterbalancing the weight of the electrode arm and the weight of the electrode parts with air, a small reversing metering pump motor can be used to accomplish the actual fluid movement in adjusting the electrodes.

Basic Electric-Arc Furnace

In the casting industry most electric furnaces have been operated with acid lining. However, during World War II, because of the difficulty in obtaining low-phosphorus scrap, a few companies found it necessary to change to basic practice. The basic electric-arc furnace probably is the most perfect single melting unit ever designed for the production of steel for any purpose. The electric furnace was sold to the foundrymen of this country on the basis of the possibilities of the basic-operated furnace, although, for the most part, casting furnaces have been operated with an acid lining.

Milwaukee District Furnaces

The writer, having spent most of his life working in the vicinity of Milwaukee and Chicago, is naturally more familiar with the history of the steel foundries in that area than elsewhere. Development of steel foundry equipment and melting practice in that district has been typical of the entire industry. At one time 13 steel foundries were operated in Milwaukee, and a brief description of the melting equipment in a few of these foundries may be of interest.

One of the older foundries in Milwaukee is the Smith Steel Foundry Co., now a division of Grede Foundries, Inc. This company was organized in 1898 as the George H. Smith Steel Casting Co., and the first melting equipment was a crucible furnace, discarded in 1900 and replaced by the first Tropenas side-blow converter installed in America. A 5-ton McLain-Carter open-hearth furnace, lined for acid operation, was installed in early 1918, operated for a short time only, and replaced in less than a year by the company's first electric furnace.

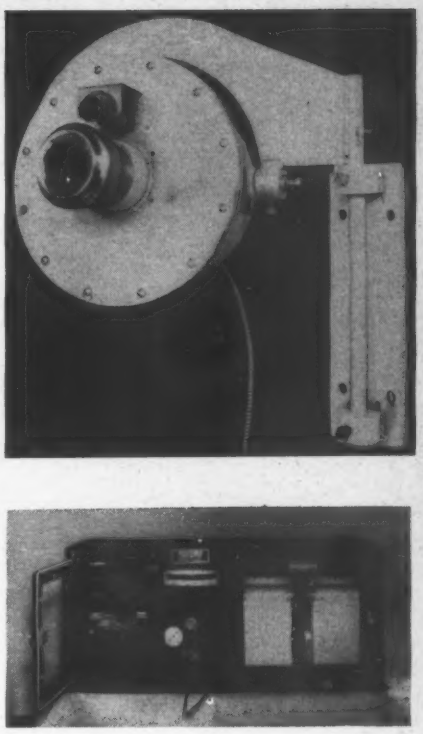


Fig. 9—Electronic flame control equipment for converter operation.

The Milwaukee Steel Foundry, also a division of Grede Foundries, was organized in 1903. This foundry started operations with Tropenas converters, but in 1918 replaced the converters with a 3-ton electric furnace, the first Heroult furnace in the Milwaukee area. It was lined for basic operation but changed to acid in 1930, at which time a 1-ton Lectromelt furnace was installed which was operated with a basic lining.

Steel Foundry

Largest steel foundry in Milwaukee is the Falk Corporation, organized in 1895. The first foundry foreman was Harry Wright, one of the great pioneer steel foundrymen of the Middle West, who helped start many steel foundries and was the organizer of the Ohio Steel Foundry at Lima, Ohio, in 1907. He had the greatest army of good steel foundry mechanics ever assembled, and they followed him from shop to shop for some ten years.

The Falk Corporation has always operated large acid open-hearth furnaces, and for a short period commencing in 1909 also operated a

Fig. 10—Two-chamber crucible installed at the Sivyer Steel Casting Co., Milwaukee, a design that came to be known as the "Milwaukee type" crucible furnace.

Stoughton side-blow converter for the manufacturer of small castings. This was installed by Arthur Simonson, who is still with the company as Vice-President and Sales Manager. Under the leadership of Harold Falk, an enthusiastic advocate of thorough apprentice training, the Falk company has been a great training school for steel foundrymen for many years.

The first electric furnace in Milwaukee was installed at the Crucible Steel Casting Co., where one of the earliest crucible furnaces also was located. The electric furnace was a single-phase, hand-controlled Snyder of ½-ton capacity, installed early in 1916. A second and similar electric furnace was installed in Milwaukee shortly afterward at the plant of the former Gerlinger Steel Casting Co.

The Sivyer Steel Casting Co., organized in 1909, commenced operations with ten oil-fired, 2-chamber crucible furnaces (Fig. 10). These were regenerative furnaces and the design came to be known as the "Milwaukee type" crucible furnace. In 1913 a 1500-lb. Tropenas converter was installed, and until 1916 castings were produced using both crucible and converter, with the converter producing the greater share of the tonnage. A 1½-ton, single-phase, hand-controlled Snyder electric furnace was installed in 1916, replaced in December, 1917, by a 3-phase furnace built by W. E. Moore. This was the first Moore furnace, and it was built by the Milwaukee Electric Railway & Light Co. Mr. Moore himself installed the furnace, which is now in the yard of the Public Service Co., located at St. Francis, Wis. (Fig. 11). The name plate attached to this museum piece reads as follows:

Born December 18, 1917
Died December 22, 1932
Served 15 Years
Melted 111,438 Tons
Tender in Years,
Tough in Service
Rest in Peace
The First Lectromelt Furnace
Cast from Its Last Heat at
Sivyer Steel Casting Company

The Moore company was later moved to Pittsburgh and is now known as the Pittsburgh Lectromelt Furnace Corp. (Fig. 12).

The writer went to Milwaukee late in 1905 with William W. Coleman, who started the steel foundry at the Bucyrus-Erie Co. (then the Bucyrus Company) in 1906. The first furnace was a 15-ton open-hearth, fired with producer gas, and was built by the old Forter-Miller Co. of Pittsburgh. It was the first basic open-hearth furnace in the State of Wisconsin.

The wonderful growth of the steel

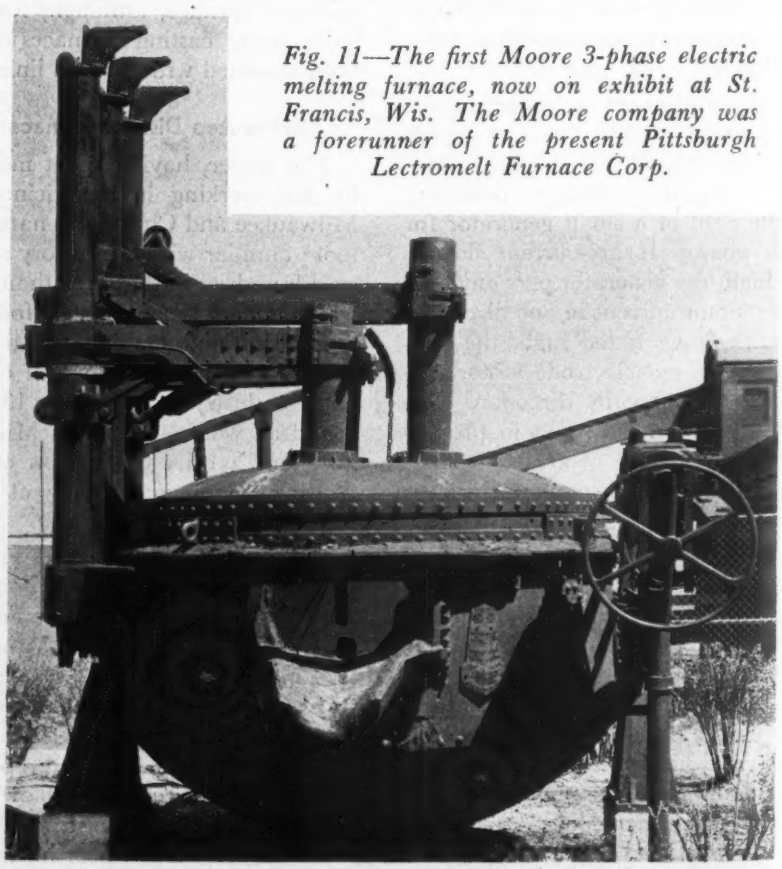


Fig. 11—The first Moore 3-phase electric melting furnace, now on exhibit at St. Francis, Wis. The Moore company was a forerunner of the present Pittsburgh Lectromelt Furnace Corp.

casting industry has been due to the continual and continuing improvement in the quality of its product. Patient study and intensive research investigations have been contributed by many men and several different technical organizations.

Special credit must be given to the American Foundrymen's Association, the Steel Founders' Society of America, the American Institute of Mining and Metallurgical Engineers, the Electric Steel Founders' Research Group, and the Electric Metal Makers' Guild. The executives, technicians and members of these organizations have spent time and money to develop improvements in all branches of foundry operations, and the results of their work have been shared generously with the entire industry.

The American Foundrymen's Association under the leadership of R. E. Kennedy, C. E. Hoyt and a host of foundry executives has consistently promoted research projects, together with cooperation and exchange of technical information, among its many members during the last fifty years.

The Steel Founders' Society under the able leadership of its Technical Director, Charles W. Briggs, has contributed greatly to improvements in melting practice and all phases of foundry work.

Research Group Formed

About 1920 a group of steel foundries, consisting of the Lebanon Steel Foundry, the Sivyer Steel Casting Co., the Fort Pitt Steel Casting Co., the Detroit Steel Casting Co., the Nugent Steel Co. and the Isaac G. Johnson Steel Casting Co., organized the Steel Founders' Research Group. The Johnson company dropped out of the organization when the plant at Spuyten Duyvil was condemned by the government to make possible the canal connecting the Hudson River with the East River. The late Major Robert A. Bull was employed as Research Director to coordinate the cooperative research projects undertaken by this group. For about eleven years this organization did an excellent job in promoting the use of and improving the quality of steel castings.

The American Institute of Mining and Metallurgical Engineers has organized open-hearth and electric furnace committees which hold regu-

Fig. 12—A modern electric furnace.

Table 3

CAPACITY, BOOKINGS AND PRODUCTION OF COMMERCIAL STEEL CASTINGS

Year	Net Tons			Production in Percentage of Capacity
	Capacity	Bookings*	Production**	
1913	903,869	305,592	.....	....
1914	898,506	458,238	.....	....
1915	939,089	676,144	.....	....
1916	991,962	1,061,399	.....	....
1917	1,017,486	895,388	.....	....
1918	1,079,914	1,133,910	.....	....
1919	1,061,137	435,066	.....	....
1920	1,466,703	997,358	.....	....
1921	1,568,660	392,165	.....	....
1922	1,495,560	1,002,025	.....	....
1923	1,577,897	1,167,644	.....	....
1924	1,614,456	1,000,963	.....	....
1925	1,663,293	981,343	.....	....
1926	1,676,263	1,039,682	1,139,859	68
1927	1,730,018	922,919	968,810	56
1928	1,761,848	1,000,283	1,021,872	58
1929	1,757,296	1,340,034	1,353,118	77
1930	1,740,126	884,433	991,872	57
1931	1,749,008	393,595	437,252	25
1932	1,774,290	157,600	177,712	10
1933	1,851,187	280,231	277,678	15
1934	1,875,363	434,131	450,087	24
1935	1,424,957	400,157	398,988	28
1936	1,438,734	909,080	805,691	56
1937	1,436,473	877,459	1,019,896	71
1938	1,318,219	333,278	342,737	26
1939	1,414,636	685,074	594,147	42
1940	1,399,907	816,919	797,947	57
1941	1,400,029	1,561,864	1,316,027	94
1942	1,957,895	2,175,661	1,679,178	86
1943	2,448,329	2,330,369	1,927,865	79

SOURCE: U. S. Department of Commerce, Bureau of Census.
*Net: Bookings less cancellations.
**Not collected by the Bureau of Census prior to 1926.
NOTE: Commercial Steel Castings are castings sold in the open market and include castings sold to producers of war material. They do not include castings produced by so-called captive foundries for incorporation into finished, assembled products of such companies.

Table 4

MONTHLY PRODUCTION CAPACITIES OF COMMERCIAL* STEEL FOUNDRIES BY STATES—SPRING, 1944

State	Number of Foundries	Net Tons
Alabama	5	3,100
Arizona	1	10
Arkansas	1	300
California	25	13,431
Colorado	1	400
Connecticut	4	1,121
Delaware	2	600
Florida	1	150
Georgia	1	30
Illinois	17	31,560
Indiana	7	19,850
Iowa	4	5,230
Kansas	1	350
Louisiana	5	1,688
Massachusetts	3	595
Michigan	19	17,883
Minnesota	2	1,050
Missouri	7	12,923
Mississippi	1	100
Nebraska	1	665
New Hampshire	1	21
New Jersey	6	2,255
New York	14	13,338
Ohio	29	37,625
Oklahoma	1	625
Oregon	6	3,630
Pennsylvania	37	55,841
Tennessee	2	1,050
Texas	8	2,962
Utah	1	300
Virginia	2	265
Washington	16	4,654
West Virginia	2	2,760
Wisconsin	11	10,498
TOTAL DISTRIBUTED	244	246,860
NOT DISTRIBUTED	26	Unknown
TOTAL	270	

SOURCE: Special Survey by Steel Founders' Society of America.
*Does not include captive foundries.
NOTE: No capacity information available for 26 steel foundries not covered by the above tabulation. They are mostly small producing units.

lar meetings at which many valuable papers have been presented covering all phases of melting practice. The last meeting of the electric furnace committee, held at Cleveland in December, 1945, drew an attendance of more than 500 men from all parts of the country.

The Electric Metal Makers' Guild is a closed organization, its membership being limited to melting superintendents and melters. Literature of the Guild is not published, but a great deal has been accomplished by educating the splendid group of men who are responsible for the actual operation of the melting equipment.

John Howe Hall, Foundry Consultant and formerly of the Taylor-Wharton Iron & Steel Co., has contributed greatly to improvements in steel foundry operation. He pioneered basic electric furnace operation in 1911 for the manufacture of austenitic manganese steel, now the standard method of production. In 1909 Mr. Hall was the first, so far as we can discover, to use pearlitic, or intermediate, manganese steel for castings containing 1.25 to 1.35 per cent manganese. In 1909 he developed commercially the practice of water quenching and tempering for carbon and alloy steel castings. In this he was only about one year ahead of Bucyrus-Erie Co., South Milwaukee, Wis., where the practice was started in 1910.

In connection with water quenching and tempering for steel castings, mention must be made of A. W. Lorenz of Bucyrus-Erie Co., who was an early advocate of this method of heat treatment. Mr. Lorenz was the author of several valuable papers on this subject, two of which can be found in the American Foundrymen's Association TRANSACTIONS (vol. 31, p. 193, 1923; and vol. 36, p. 141, 1928). Lorenz's untimely death occurred October 1, 1934, at which time he was Chairman of the Heat Treating Committees of A.F.A. and the American Society for Metals. His death was a distinct loss to the entire steel casting industry.

All manufacturers of steel, by whatever process, are making cleaner steel and better castings because of the resarch work done by Dr. C. H. Herty of the Bethlehem Steel Co. and C. E. Sims of Battelle Memorial Institute. Fred W. Melmoth, formerly of the Detroit Steel Casting Co., is another who has given freely of his time in preparing papers on technical subjects pertaining to the making and treating of steel castings. Harry F. McQuaid of the War Production Board has made many valuable contributions for the improvement of all kinds of steel castings. Space does not permit inclusion of many others worthy of mention.

Chemical and physical specifications have kept pace with the improvement of steel castings. An early specification was published in the American Foundrymen's Association TRANSACTIONS of 1898 which read as follows:

Tensile strength—70,000 psi. (if possible)
Elongation in 2"—25 per cent
Reduction of area—36 per cent

Minimum Tolerances

Tensile strength—60,000 psi.
Elongation in 2"—18 per cent
Reduction of area—30 per cent

It is only necessary to compare this simple specification with the elaborate requirements of the American Society for Testing Materials, published in their Standards of 1944, to realize what a long road has been traveled by the steel foundry industry in the last fifty years. Incidentally, the American Foundrymen's Association is a charter member of the A.S.T.M. and maintains memberships on all committees dealing with specifications for steel castings.

At the beginning of the century the production of steel castings in America was approximately 200,000 tons per year. During the last World War this figure had reached the surprising total of over 2,000,000 tons per year, produced in 293 steel foundries (Tables 3, 4 and 5).

Acknowledgment

The writer wishes to express his great appreciation to the good friends who have furnished informa-

(EDITOR'S NOTE: See also *"50 Years of Progress in Castings Specifications,"* by John W. Bolton, in the April 1946 issue of AMERICAN FOUNDRYMAN.)

Table 5

PRODUCTION OF STEEL CASTINGS BY CLASSES AND BY MELTING PROCESSES AS REPORTED BY 23 CAPTIVE STEEL FOUNDRIES FOR THE YEAR 1943

Class of Castings	Net Tons			
	Open Hearth	Electric	Converter	Total
Carbon Steel	13,589	23,305	14,833	53,727
Low Alloy Steel	32,693	59,429	1,050	93,172
High Alloy	.....	236	.....	236
ALL CLASSES	46,282	84,970	15,883	147,135

SOURCE: Special Survey by Steel Founders' Society of America.

tion useful in the preparation of this survey. He wishes to acknowledge particularly his indebtedness to the men listed below:

J. A. Anderson, Bucyrus-Erie Co.
C. W. Briggs, Steel Founders' Society of America.
A. C. Blumberg, Wehr Steel Co.
W. W. Coleman, Bucyrus-Erie Co.
Anthony DeYoung, Whiting Corporation.
James Ewens, Smith Steel Casting Co.
E. D. Fahlberg, Grede Foundries, Inc.
George P. Fisher, Whiting Corporation.
J. H. Hall, Foundry Consultant (formerly Taylor-Wharton Iron & Steel Co.)
Harry Hanlon, Wisconsin Electric Power Co.
Arthur Jameson, Malleable Iron Fittings Co.
Emory Johnson, Malleable Iron Fittings Co.
R. E. Kennedy, American Foundrymen's Association.
L. W. Long, Allis-Chalmers Mfg. Co.
J. E. McCullough, National Malleable & Steel Castings Co.
Fred W. Melmoth (formerly Detroit Steel Castings Co.)
T. B. Montgomery, Allis-Chalmers Mfg. Co.
V. J. Murdock, Allis-Chalmers Mfg. Co.
John H. Owen, Harbison-Walker Co.
John Porter, American Steel Foundries.
T. S. Quinn, Lebanon Steel Foundry.
W. M. Shober, Allis-Chalmers Mfg. Co.
Arthur Simonson, Falk Corp.
Fred B. Skeates, Link Belt Co.
E. F. Stachel, Wisconsin Electric Power Co.
James Sweitzer, Sivyer Steel Casting Co.
J. S. Townsend, Carnegie-Illinois Steel Co.
F. W. Wagner, Wisconsin Electric Power Co.
B. C. Wait, Milwaukee Steel Foundry Co.
W. B. Wallis, Pittsburgh Lectromelt Furnace Corp.
Walter Wright, Sawbrook Steel Casting Co.
David Zuege, Sivyer Steel Casting Co.

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TRANSACTIONS, American Foundrymen's Association, vols. 1-21 (1898-1912).

"Making, Shaping and Heat Treating of Steel," U. S. Steel Corp. 5th edition.

Proceedings, American Institute of Mining and Metallurgical Engineers, Electric Furnace Conferences, 1943-44.

Steel Castings Industry, Steel Founders' Society of America.

Steel Casting Handbook, Steel Founders' Society of America.

D. C. Miner, sales manager, E. F. Houghton & Co., Philadelphia, was recently elected chairman of the Exhibitors' Advisory Council.

PETROLEUM COMPANY
Builds New South American Foundry

A NEW FOUNDRY has been constructed by the International Petroleum Co. on the company's property at Negritos, Talara, Peru, S. A. The foundry is to be used as a repair and fabricating center. Built entirely from available materials within the district, this foundry is quite modern. The steel reinforced brick structure houses cranes, air hoists, gas fired brass and annealing furnaces, an all steel encased tilting open hearth furnace, two cupolas and a side blow converter.

Figure 1, in the upright position, is the tilting open hearth furnace viewed from the pouring side. Note the two doors to the slag pockets. Fig. 1 (insert) illustrates the furnace in the pouring position.

According to available information the tilting mechanism is operated by a 6 hp. motor; time required to tilt the furnace is 45 seconds. No difficulty has been incurred in tilting the furnace. This is due to the particular type of furnace construction. The furnace necks entering into each of the air uptakes are made with a brick flange, and they have an air seal that provides free movement without allowing any flame to pass through.

Figure 2 shows the tilting open hearth from the charging side. Built into each end of the charging platform are the two venturi exhaust stacks while the air intake pipe is in the middle.

Concerning the performance characteristics of the furnace, it has a melting capacity of five tons and is fired with natural gas. An air pressure of about one lb. per sq. in. is required, however, the volume of air varies with the amount of natural gas used. Air is furnished by a blower powered with a 30 hp. electric motor. It requires from three to four hours to heat the furnace from 1400 to 3100° F., and once the temperature is obtained very little gas is required to maintain it. During the melting period a close control has to be maintained over the air to gas ratio in order to have a reducing flame at all times. Any desired temperature is easily and quickly obtained due to forced air, and the forced draft through the venturi stacks. There are no difficulties encountered with air infiltration into the furnace system as it is steel enclosed, and the large amount of draft obtainable through the venturi stacks more than takes care of any air entering the doors or furnace necks.

Iron from the furnace shows a fine grain structure and high strength,

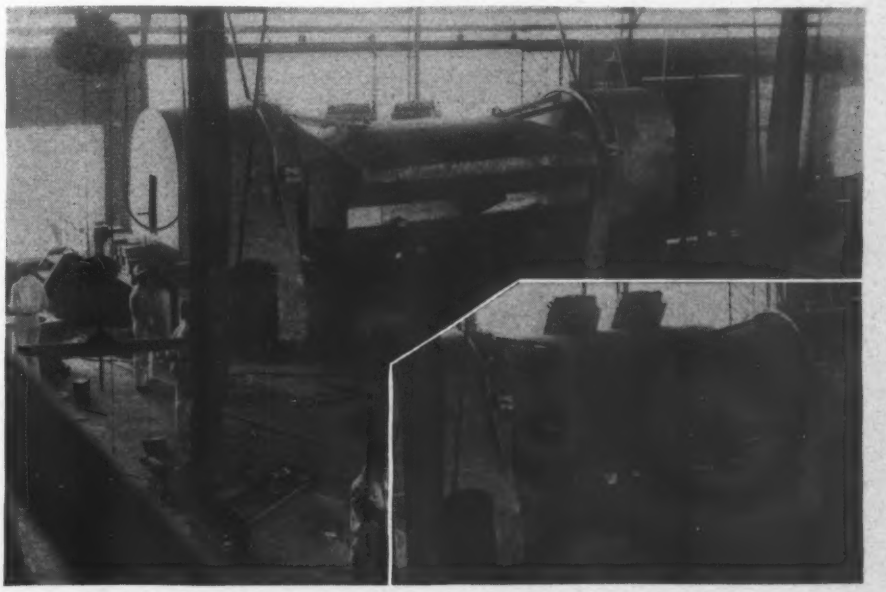


Fig. 1—Steel enclosed tilting open hearth furnace in upright position. (Insert)—Furnace in pouring position.

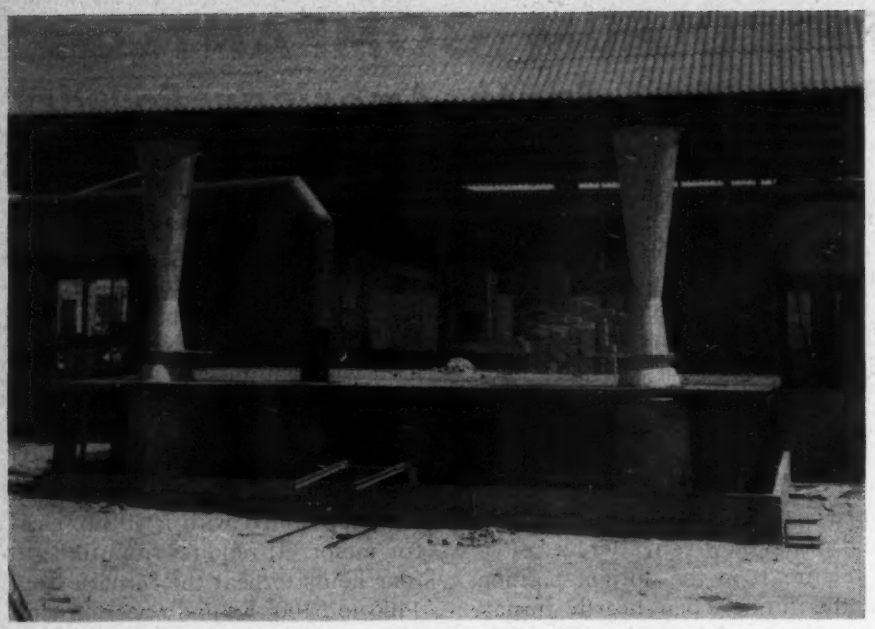


Fig. 2—Back view of tilting open hearth showing charging platform and two charging doors. Note air intake pipe and two venturi exhaust stacks.

which makes it suitable for machinery parts that require good wearing properties.

The furnace was built mainly for either cast iron or steel of different types suitable for producing sand castings for oil field machinery equipment.

The cost of building the furnace was extremely low, about 10 to 20 per cent cheaper than a similar furnace would cost here, as it was designed and built at the South American plant.

Two natural gas fired brass furnaces and two heat treating and annealing furnaces can be seen in Fig. 3. Each furnace has a capacity of 400 lb. of metal every four hours. Manganese, phosphor, silicon and aluminum bronzes are made in these units with good results. A slag covering is used to obtain deoxidized metal. Melting time, slag composition and metal temperature must be closely controlled, depending upon the type of bronze to be made.

The cupolas are used to make different types of cast iron, varying in composition from one that contains no steel charge to one made from all steel. A cast iron made with 25 per cent scrap and 75 per cent steel produces a metal very satisfactory for casting, and one that has excellent machining and high strength properties. Cupolas are equipped with air meters and continuous tuyeres which improve their efficiency and controllability. Lining wear in the cupola has been reduced to a minimum by using crushed silica rock to a minus ⅜ in. and charging 20 lb. in an 800 lb. charge of cast iron. Sand castings weighing over two tons have been made.

Make Own Brick

Silica bricks for the furnaces are made at the plant. Materials used are obtained from the company's property. Bricks are made from quartz rock which is mined and crushed to minus one in. A 150 lb. of crushed quartz and 50 lb. of old bricks with ¾ pail of water, two lb. of lime and two lb. of clay are ground in a mill for 20 to 30 minutes, depending upon the fineness required. Bricks are molded by hand, dried in drying furnaces at 250° F. and placed in a small furnace—capacity 300 bricks. They are then burned by gradually raising the furnace temperature to 2400° F. in 18 hours and then holding that temperature for six hours. The bricks are then slowly cooled for 14 hours and rapidly cooled in eight hours. A melting point of 3200° F. is characteristic of these bricks. Approximately 30,000 bricks have been made for furnace use.

All of the bricks for the tilting open hearth furnace are of a special shape and consist of 96 per cent silica, two per cent lime, and two per cent alumina, iron and magnesia. All of the roof bricks for the tilting open hearth furnace are suspended both in the checkers and over the hearth by means of steel rods passing through the ends of the brick. The bricks in the walls of the uptakes, around the furnace neck and gas inlet are reinforced and suspended in the same manner.

The quartz rock for the manufacture of the brick was obtained from a quartz vein, 40 to 60 ft. wide, that cuts through the company's property. The vein shows some mineralization, but as yet no workable ore deposits or ore shoots have been discovered. The clay also occurs on company property in the form of a large bed of kaolin clay, 20 to 30 ft. in thickness. Relatively free from iron, the clay is high in whitish color properties and has a very fine practical size. Both of these deposits have an economic importance.

Fig. 3—Two natural gas fired melting furnaces and heat treating and annealing furnaces used for non-ferrous work.

FOUNDRY EDUCATION

Advances Through Widespread Interest

WINNING RECOGNITION in many quarters of its vital importance to the American economic picture, technological training for the foundry is currently scoring gains in the field of formal education and in other, more general, educational activities, along with the broad trend of metallurgy as a whole.

Recent news despatches from various sources reflect the impact of demand for skilled personnel; and the pressure of such activities as A.F.A. Technical Development Program.

Reading Lecture Course

THE foundrymen of Reading successfully sponsored an 11-week elementary foundry lecture course. Meetings were held in Wyomissing Polytechnic Institute, Wyomissing, Pa. The first lecture session was held Thursday evening, February 7, and sessions were held each Thursday evening thereafter until April 18. The course was open to all interested persons in the foundry and allied industries.

The committee in charge of the course included: Chairman Hermann P. Good, superintendent foundry division, Textile Machine Works, Reading; W. M. Davies, superintendent, Reading Foundry & Supply Co., Reading; Werner G. Finster, chief metallurgist, American Chain & Cable Co., York, Pa.; William Bricker, instructor, Reading Senior High School, Reading; Robert P. Fritch, president, Union Bronze Co., Reading; and Arthur Harper, president, Wyomissing Polytechnic Institute.

Vancouver Foundry Research

ARRANGEMENTS FOR an experimental foundry station at Vancouver Technical School, Vancouver, Can., have been completed by the British Columbia Industrial and Scientific Research Council, of the same city, and local school board trustees, Hon. E. C. Carson, chairman of the Council, has announced.

The research program, instituted at request of the metal industries is designed to assist the 58 foundries in British Columbia in retaining as much as possible of new business acquired during the war, it was reported.

Scientific investigations will be conducted on all phases of foundry practice. Such aspects as development of molding sands from local deposits, improvements in casting techniques for both ferrous and nonferrous metals and development of suitable coke will be studied.

Towne Metallurgy Department

UNDER DIRECTION of Dr. R. M. Brick, formerly assistant professor of metallurgy, Yale University, New Haven, Conn., the newly established Department of Metallurgy, Towne Scientific School, University of Pennsylvania, Philadelphia, will offer undergraduate and graduate programs, Dr. G. W. McClelland, Pennsylvania university president, revealed in a recent statement.

Assembling for the new department is a staff of metallurgical specialists, which will have available a laboratory of 6,500 sq. ft. floor space, equipped with latest precision apparatus for instruction and research. A limited number of students will be admitted to the department with opening of the next fall term.

Dr. Brick, appointed head of the department and professor of metallurgy, holds a metallurgical engineering degree from Lehigh University, Bethlehem, Pa., and the degree of doctor of philosophy from Yale University. After receiving the latter Dr. Brick carried on fundamental research at Yale, as a Sterling Research Fellow; a paper based on this work winning him, in 1936, the annual prize award of the AIME. He has been active in A.F.A., ASM and AIME, and has contributed to many research publications, in addition to writing a textbook, *"Structure and Properties of Alloys."*

Surface Reaction Symposium

BRINGING TOGETHER a number of outstanding authorities for the occasion, the Pittsburgh Section, Electrochemical Society, is sponsoring a symposium on "Surface Reactions," June 7, at Mellon Institute of Industrial Research, Pittsburgh, Pa.

Under chairmanship of Dr. J. P. Fugassi, Carnegie Institute of Technology, Pittsburgh, the morning session, opening at 9:30 am, will hear: *The Chemical Structure of Thin Oxide Films on Metals and Alloys Formed at Elevated Temperatures,* Dr. J. W. Hickman, Westinghouse Research Laboratories, East Pittsburgh, Pa.; *Surface Area Measurement on Metal Surfaces,* Dr. P. H. Emmett, Mellon Institute of Industrial Research; and *Theory of Oxidation and Tarnishing,* Dr. W. E. Campbell, Bell Telephone Laboratories, New York.

The afternoon session, with Dr. E. A. Gulbransen, Westinghouse Research Laboratories, presiding, will begin at 2:30 pm. Discussed will be: *Relation Between Solid Binding and Surface Structures,* Dr. Frederick Seitz, Carnegie Institute of Technology; *Reactions Attendant with Carburization-Decarburization of Steels,* J. K. Stanley, Westinghouse Research Laboratories; and *Thermodynamics of Surfaces and Solutions,* Dr. J. C. Warner, Carnegie Institute of Technology.

University students, who are urged to attend, will be admitted without payment of registration fee.

Erie Foundry Classes

INAUGURATION of foundry practice classes, with the fall semester, at Academy High School, Erie, Pa., will launch an educational program sponsored by the Northwestern Pennsylvania A.F.A. chapter, and expected to benefit local foundries and the industry in general within a short time.

Before a large group of boys assembled in the school auditorium recently, J. E. Jeffries, technical vocational director, Erie School District, aroused considerable enthusiasm with a discussion of the forthcoming course. An enlarged room in the school will be equipped by local foundries, and a competent instructor will be added to the faculty.

Representing the Northwestern Pennsylvania chapter at the assembly as Mr. Jeffries laid the groundwork for the project, were: Chapter Vice-Chairman E. M. Strick, Erie Malleable Iron Co., Erie; and Chapter Director L. A. Dunn, General Electric Co., Erie.

Mr. Dunn is chairman of the chapter technical education committee, which also includes: Chapter Chairman R. W. Griswold, Jr., Griswold Mfg. Co., Erie; and J. R. Metcalf, Erie Malleable Iron Co.

COPPER AND THE STEEL CASTING

An Alloy for POSTWAR CONSIDERATION

H. F. Taylor
H. F. Bishop
and
R. C. Wayne

COPPER HAS BEEN EMPLOYED as an alloying element in many of the so-called high yield strength, low-alloy structural steels for a number of years. It has not been used widely in wrought steels for machine parts and there are no S.A.E. or N.E. steels which contain copper other than in residual quantities.

Although the limited supply of copper in time of war alone could account for the omission of this element in the N.E. steels, two other reasons exist for not using it. When more than 0.4 per cent copper is present, steels become subject to edge-cracking in the rolling operation unless the temperature is carefully controlled or unless sufficient nickel is present to counteract this difficulty.

Mechanical Properties Affected

The second reason is that the beneficial effects on mechanical properties conferred by copper are more pronounced after normalizing and tempering than after quenching and tempering, in which latter condition most of the S.A.E. and N.E. steels are used; moreover, the benefits are most evident when the carbon content is 0.20 per cent or lower, and most of the S.A.E. or N.E. steels are used at higher carbon contents unless they are case-hardened.

Difficulties outlined in the foregoing naturally restrict the use of copper to structural steels, certain special purpose steels, steels for heavy forgings (which usually contain appreciable quantities of nickel) and steel castings. Although copper has not been used widely in the steel castings industry except by the Pacific Car and Foundry Co. and by the Ford Motor Co., the excellent casting characteristics and high physical properties, which can be developed in both light and heavy sections, should make the copper alloy steels of interest for postwar castings.

Although much work has been done on the heat treatment and physical properties of copper steels by other investigators, it was considered advisable to check certain of these results and also to study weldability, mass effect, and high and low temperature properties of these steels to determine if it was desirable to widen their sphere of application. The results which are reported herein were obtained before copper became a critical metal during the war.

Brief Review of Existing Knowledge. Several outstanding advantages of copper-silicon cast steels are worth considering in choosing a high strength, low alloy steel of weldable grade for castings.

From the standpoint of casting long, thin members, copper steels are unique. When sufficient copper is added in combination with higher than normal silicon, steels become very fluid in the molten condition. Finlayson[10] has reported that boom castings with overall lengths of approximately 11 ft. and maximum metal thickness of ½ in. can be molded in green sand and poured through a single gate at one end.

Both Kinnear[4] and Nehl[2] made early investigations upon copper cast steels containing normal amounts of manganese and silicon. Kinnear was the first to predict the practical advantages of the precipitation hardening (aging or age hardening) of copper steels. This heat treatment gives maximum strength with little or no change in ductility over the annealed steels.

Iron-Copper Diagram

According to the iron-copper equilibrium diagram of Norton[6], iron can dissolve about 1.5 per cent of copper at 1531° F. (833° C.) but retains only about 0.35 per cent in solution below 1200° F. (650° C.). However, the copper dissolved in excess of 0.35 per cent is precipitated only upon very slow cooling (some of the dissolved copper being retained in solid solution at the center of heavy sections even after air-cooling) and it is difficult to produce the desired sizes of precipitated particles in the cooling cycle.

Therefore, to obtain optimum particle size consistently and throughout varying cross-sections, it is good practice to retain, at room temperature, all of the copper which was in solution at the heating temperature by using the proper cooling rate and then precipitating the copper by reheating. The control of time and temperature is not too critical, as will be shown by data which are included in this paper.

Copper steels differ from most

The opinions expressed are those of the authors, H. F. Taylor (now Research Associate at M.I.T., Cambridge, Mass.), H. F. Bishop, and R. C. Wayne, Steel Castings Section, Division of Physical Metallurgy, Naval Research Laboratory of the Office of Research and Inventions, Washington, D. C., and do not necessarily reflect the views of the Navy Dept.

other precipitation hardenable alloys in their capacity to increase in strength and hardness without a serious loss in ductility. This may be due to the fact that the submicroscopic, keying particles of copper precipitated upon artificial aging are relatively soft, and yield plastically under deformation.

A high yield to tensile strength ratio is typical of precipitation hardened alloys; in "as normalized" copper steels, the marked increase in this ratio is undoubtedly due to some precipitation of properly-sized copper particles upon air cooling.

Copper Does Not Oxidize

Another advantage of using copper as an alloying element in steel for castings is the fact that copper is not lost by oxidation or volatilization in the melting process. Heads, gates, and other return scrap yield all of their copper upon remelting.

A mass of data on copper steels has been compiled by Gregg and Daniloff[7]. Lorig and his co-workers[8, 9] have contributed much to the knowledge of copper steels, and other investigators have been active in this field. A chronological selected bibliography on copper steels appears at the end of this paper.

Specimen Preparation. The steels used in this work were melted in a 300-lb. acid induction furnace. Sheared S.A.E. 1015 steel and ingot iron were used as melting stock. Ferro-alloys were used for alloy additions except nickel and copper, which were added as commercially pure metals. The steels were sand-cast in 60-lb. coupons of the type shown in Fig. 1. The projecting fingers were sawed from the main bodies of the coupons before they were heat treated.

Shoulder-grip, 0.505-in. diameter tensile specimens were machined from these blanks and tested according to conventional methods unless otherwise noted. Blanks for impact specimens were cut from the bottom portions of the coupons and were heat treated before they were machined to standard Charpy key-hole notch specimens unless otherwise indicated. Each physical property test was made in duplicate.

Effect of Copper on Tensile Properties. Figure 2 shows the tensile properties of a steel containing 0.15 per cent carbon, 0.40 per cent silicon and 0.60 per cent manganese at eight copper contents from 0.09 per cent to 2.10 per cent in two conditions of heat treatment; normalized, and normalized and aged.

Tensile Strength Affected

Effect of aging upon tensile strength and yield strength begins to appear when about 0.50 per cent copper is present, and the strengthening effect increases with increasing copper content until about 1.5 per cent is present; beyond that amount, little additional strengthening occurs. By adding 1.5 per cent copper to the base composition and aging after normalizing, the yield strength is doubled, increasing from 38,000 to 80,000 psi., while the tensile strength is increased from 60,000 to 100,000 psi.

Reduction of area and elongation values are erratic after aging and are lower than might be expected. However, this particular base composition is not well suited to the development of the best properties in precipitation hardened copper steels and serves only as an illustration of the limits within which copper is effective as a precipitation hardening agent.

Effect of Manganese on Tensile Properties. Figures 3 and 4 illustrate the influence of manganese on the mechanical properties of low carbon copper steels. Manganese slightly improves the strength of copper steels which are annealed, and normalized and tempered but, as the manganese content increases, the steel becomes less responsive to the aging heat treatment.

Effect of Silicon on Tensile Properties. It has been stated that silicon and copper are effective in increasing the fluidity of molten steel. A series of copper steels with increasing silicon contents was cast into test coupons to determine whether or not the increased silicon would have any detrimental effect upon the physical properties. The results obtained from tests on these steels after four different heat treatments are shown in Figs. 5 and 6.

When both the manganese and silicon are about 1.00 per cent, a

Copper increases the yield and tensile strengths and yield ratios of steels to which it is added. This increase in yield strength to tensile strength ratio makes low alloy copper-bearing cast steels particularly useful for castings where a saving in weight is desirable. These improvements are obtained without materially affecting ductility. With manganese and silicon present in amounts higher than normal, an excellent combination of properties is obtained.

With copper contents above about 0.6 per cent these steels can be precipitation hardened (aged) without liquid quenching to further increase the yield and tensile strengths. In the annealed condition a copper steel containing 0.15 per cent carbon with manganese and silicon each at approximately 1.00 per cent will have a yield strength of 60,000 psi., and by aging this steel after normalizing a yield strength of 90,000 psi. is possible. Copper steels in the aged condition have low impact resistance as measured by Charpy and Izod tests, but have good elongation and reduction of area. Because a supersaturated solution of copper in ferrite is obtained by even very slow cooling, sections as large as 8 in. can be hardened throughout by the precipitation strengthening draw after normalizing.

Copper cast steels are best below 0.20 per cent carbon, and if kept within this limit have good weldability. With approximately 0.10 per cent carbon present, these steels are readily weldable without preheating or postheating at yield strengths above 50,000 psi. The combination of copper and 1.00 per cent or more silicon produces excellent fluidity in these steels. They do not become brittle at subzero temperatures, and high temperature tensile tests indicate that copper steels containing about 0.50 per cent molybdenum show promise for service at moderately high temperatures. The resistance of copper-bearing steels to atmospheric corrosion is well known, and curves are presented showing copper steels to be more resistant to scaling during heat treating than are plain carbon or carbon-molybdenum steels.

very good combination of properties is obtained. Figure 7 shows some properties of high silicon-manganese steels with the copper varying from about 1.10 to 1.80 per cent.

It is a peculiarity of this composition that aging after normalizing increases the reduction of area value by about 5 per cent as well as the yield and tensile strength, while the elongation decreases slightly. This anomaly has been noticed many times and is caused by the fact that the ductility of the aged tensile bar manifests itself in a localized area with a very pronounced "necking."

Effect of Carbon. Since copper is soluble in ferrite, the precipitation hardening effect is most pronounced in low carbon steels. Copper steels should not contain over 0.25 per cent carbon and preferably the carbon content should be less than 0.20 per cent, not only because the best combination of physical properties is obtained within this range, but also because these steels are weldable, as is shown later in this paper.

Stress Relieved

In the stress relieved condition, obtained by annealing or normalizing and tempering, a copper steel containing 0.15 per cent carbon, as shown in Fig. 8, has a yield strength of 60,000 psi. with excellent ductility and impact resistance. When this same steel is normalized and aged, the yield strength is raised to almost 90,000 psi., as shown in Fig. 9, and good elongation and reduction of area are maintained. The impact resistance of copper steels always drops considerably on aging.

The curves of Fig. 9 show how the precipitation strengthening effect decreases with increasing carbon. With 0.10 per cent carbon the yield strength of a normalized steel is increased by 20,000 psi. due to the precipitation hardening draw, while a steel containing 0.25 per cent carbon shows an increase of only about 10,000 psi. Figure 10, taken from work by Williams and Lorig[9], shows the same behavior for rolled steels over a much greater carbon range.

Cumulative Effect of Copper, Manganese, and Silicon. It was found that in order to obtain the best combination of strength and ductility in copper steels either the manganese or silicon contents or both should be about 1.00 per cent. Low carbon copper steels containing 1.00 per cent manganese and 1.25 per cent silicon have been used in making commercial castings with very good results. This alloy presents no melting problems, and has excellent fluidity, and high strength and ductility.

Table 1 lists the properties of a plain carbon steel and also a copper steel of the same carbon content but with 1.25 per cent silicon and 1.00 per cent manganese present. Table 2 lists the improvements in tensile and yield strengths which are caused by the copper and the excess silicon and manganese over that present in the base steel; the effect of each element is determined separately by increasing the amount of one element in the steel and holding the other two constant.

The sum of improvements due to each element on the yield and tensile strengths of the steel is 17,000 and 14,500 psi., respectively, while the improvement due to the combination of these elements, as shown in Table 1, is 26,000 psi. in yield strength and 18,000 psi. in tensile strength.

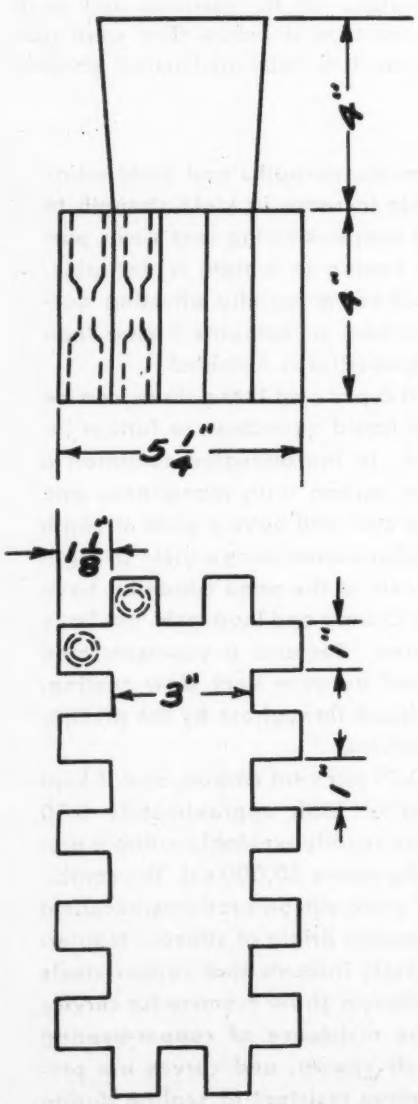


Fig. 1—Views of test coupon.

Table 1

COMPARISON OF PLAIN CARBON AND COPPER BEARING CAST STEELS

Normalized 1700° F. (930° C.)
Tempered 1200° F. (650° C.)

	Composition			
Steel	*C*	*Mn*	*Si*	*Cu*
A	0.20	1.0	1.25	1.75
B	0.20	0.7	0.35	0.00

	Physical Properties			
Steel	*Tensile Strength, psi.*	*Yield Strength, psi.*	*Elongation, per cent in 2 in.*	*Reduction of Area, per cent*
A	86,000	62,000	28.0	57.0
B	68,000	36,000	32.0	56.0
Increase	18,000	26,000	—4.0	1.0

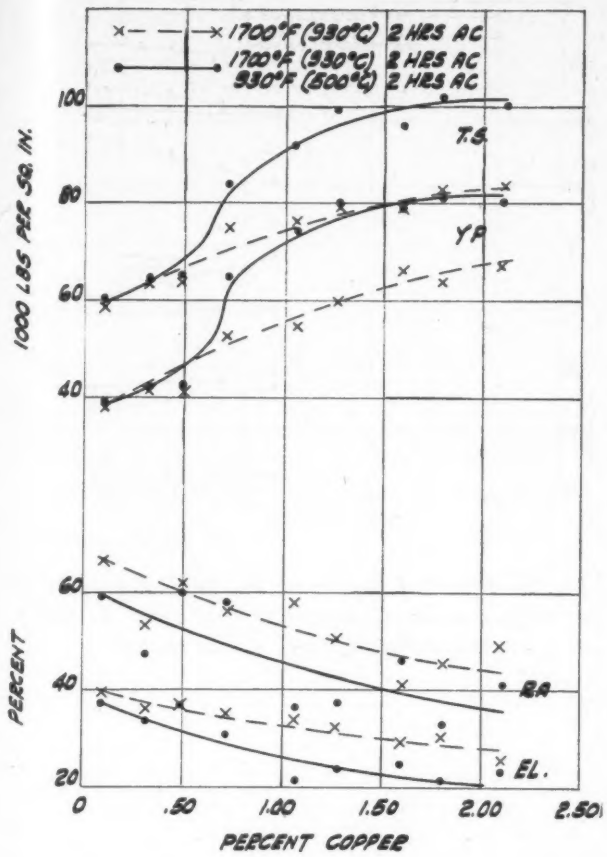
This increase in the yield strength is not accounted for when the effects of each element are added together, the cumulative effect being roughly twice the total effect of each element considered separately. It has recently been shown that the cumulative effect of alloy additions is obtained by multiplying factors for each element in the alloy rather than by adding these effects directly.

Copper Affects Yield Strength

Tables 1 and 2 show the marked influence of copper on yield strength. High yield strengths and yield ratios are characteristic of copper bearing steels. The data presented in these tables are for normalized and tempered steels. By aging these steels, further increases of between 20,000 and 30,000 psi. can be obtained.

Aging Time and Temperature. The tensile properties obtained by aging a copper steel at 870° F. (465° C.) and 930° F. (500° C.) for varying lengths of time are shown by the curves of Fig. 11. By aging at 930° F. (500° C.) maximum strength is reached in about 3 hr., and the strength decreases after about 6 hr. when the over-aging effect becomes pronounced.

When aging takes place at a lower temperature, 870° F. (465° C.), changes occur less rapidly, with maximum strength being reached after about 8 hr., and no marked over-aging is apparent even after 16 hr. For commercial practice, a good



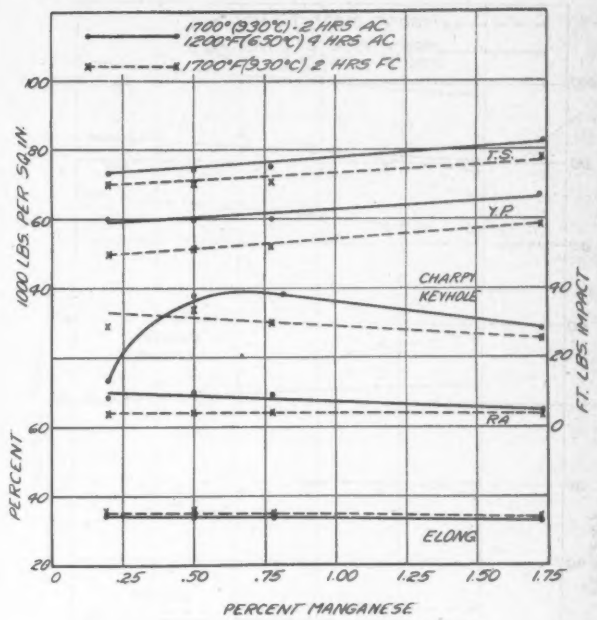
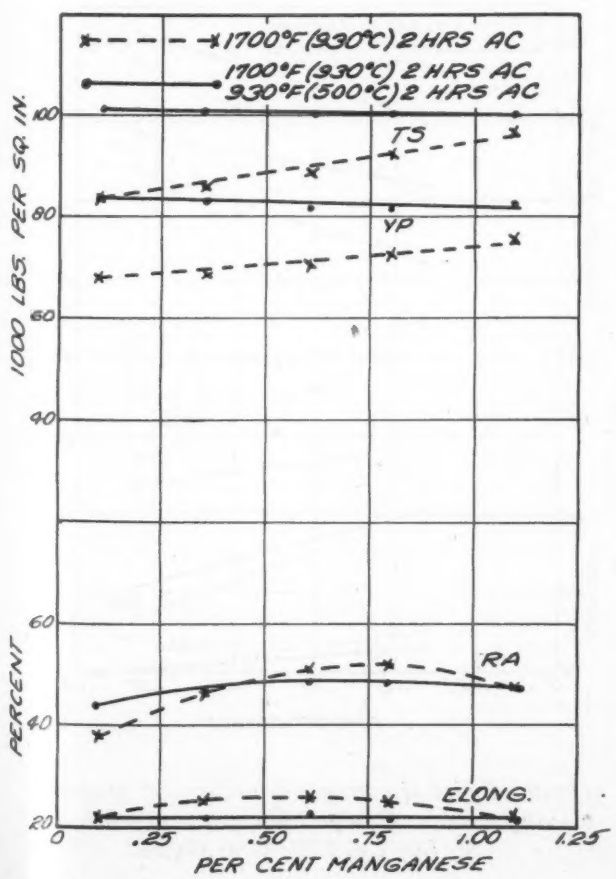


Fig. 2 (left)—Effect of copper on mechanical properties of copper steels. Composition, per cent —C, 0.15; Mn, 0.60; Si, 0.40; Cu as shown.

Fig 3 (above)—Effect of manganese on mechanical properties of copper steels. Composition, per cent—C, 0.08; Si, 1.00; Cu, 1.75; Mn as shown.



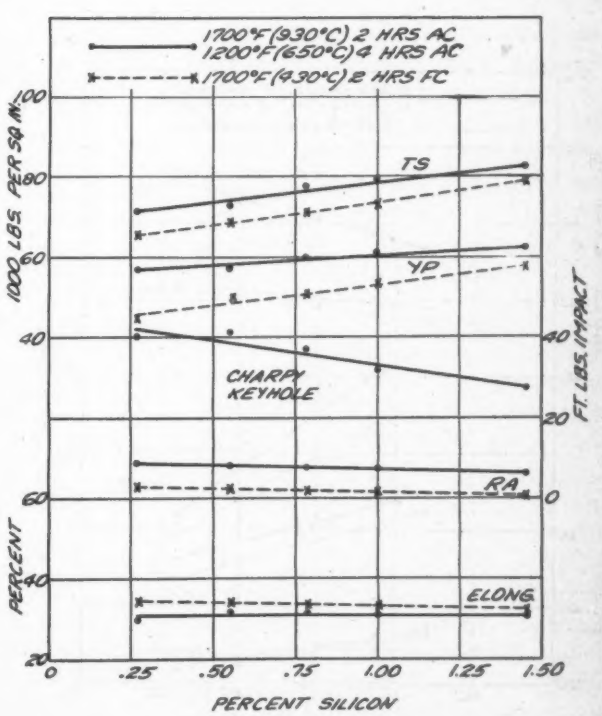


Fig. 4 (left)—Effect of manganese on alloy of composition, per cent—C, 0.12; Si, 1.07; Cu, 2.08.

Fig. 5 (above)—Effect of silicon on alloy of composition, per cent—C, 0.12; Mn, 0.83; Cu, 1.85.

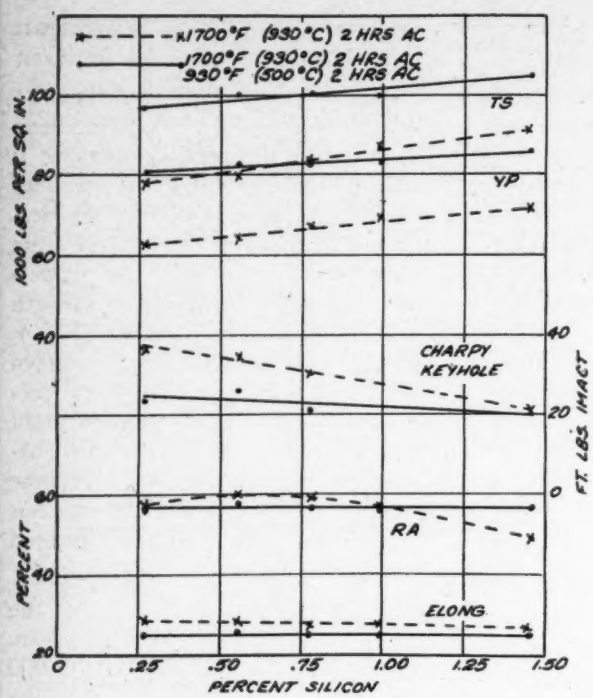


Fig. 6—Effect of silicon on mechanical properties of copper steels. Composition, per cent—C, 0.12; Mn, 0.83; Cu, 1.85; Si as shown.

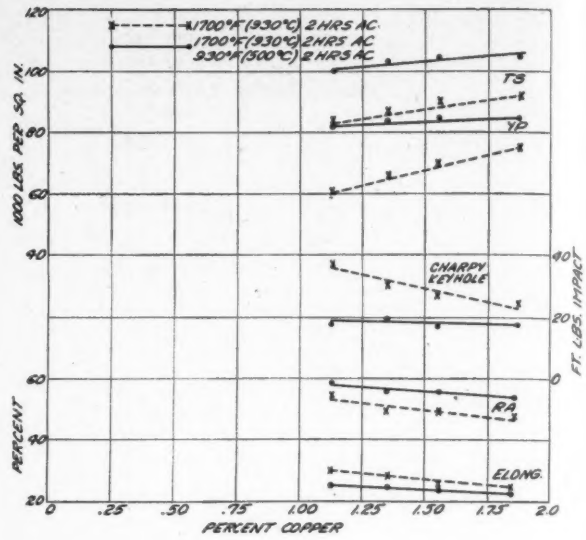


Fig. 7—Effect of copper on mechanical properties of copper steels. Composition, per cent—C, 0.16; Mn, 0.96; Si, 1.07; Cu as shown.

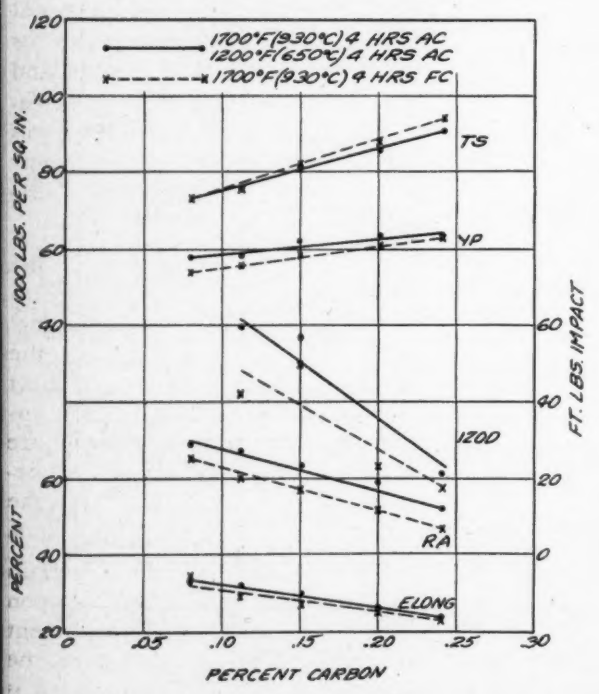


Fig. 8—Effect of carbon on mechanical properties of copper steels. Composition, per cent—Mn, 1.0; Si, 1.0; Cu, 1.75; C as shown.

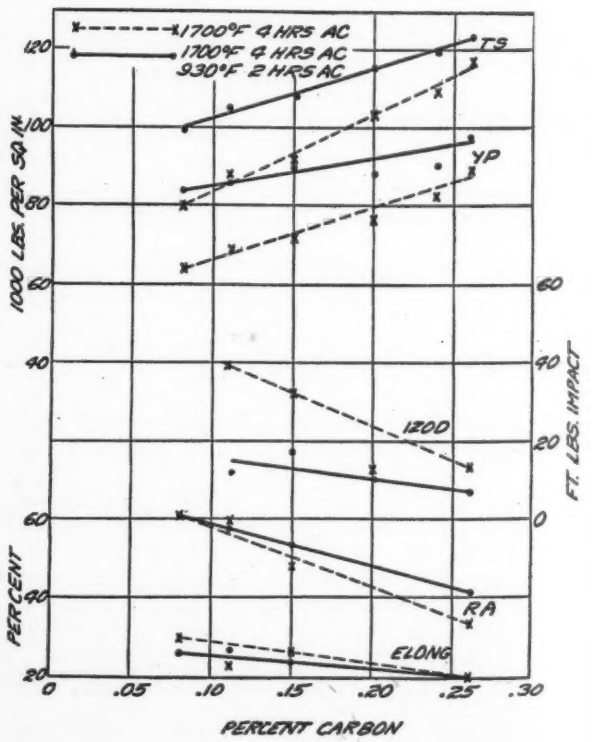


Fig. 9—Effect of carbon on mechanical properties of copper steels. Composition, per cent—Mn, 1.0; Si, 1.0; Cu, 1.75; C as shown.

Table 2

EFFECT OF COPPER, MANGANESE, AND SILICON ON COPPER STEELS

Normalized 1700° F. (930° C.) — Tempered 1200° F. (650° C.)

Composition, per cent				Properties			
C	Mn	Si	Cu	Tensile Strength, psi.	Yield Strength, psi.	Elongation, per cent in 2 in.	Reduction of Area, per cent
0.17	1.21	0.97	1.50	87,000	66,000	30	61
0.17	1.21	0.97	—	81,000	57,000	31	63
Increase caused by raising Cu from 0.0 to 1.5 per cent.....				6,000	9,000	—1	—2
0.08	1.00	1.00	1.75	78,000	63,000	33	67
0.08	0.70	1.00	1.75	77,000	62,000	33	68
Increase caused by raising Mn from 0.70 to 1.00 per cent.....				1,000	1,000	—	—1
0.12	0.83	1.25	1.85	82,000	62,000	31	67
0.12	0.83	0.35	1.85	72,000	57,500	31	69
Increase caused by raising Si from 0.35 to 1.25 per cent.....				10,000	4,500	—	—2
Total of Increases.....				17,000	14,500	—1	—5

Table 3

WELD PROPERTIES USING TEE BEND TEST

(Test pieces annealed after casting.)

Heat No.	Composition, per cent C	Mn	Si	Cu	Mo	Test Piece	Heat Treatment	Max. Load, lb.	Angle at Max. Load, degrees	Angle at Fracture, degrees
B	0.21	0.75	0.40	—	—	Cast Fillet	As Annealed	8,400	71	
						Weld Fillet	As Welded	8,100	62	
						Weld Fillet	1200° F. (650° C.) 1 hr. AC	8,800	71	
G	0.17	0.61	0.44	—	0.51	Cast Fillet	As Annealed	10,300	73	
						Weld Fillet	As Welded	7,850	56	
						Weld Fillet	1200° F. (650° C.) 1 hr. AC	8,100	75	
M	0.11	0.63	0.92	1.79	—	Cast Fillet	As Annealed	8,250	68	92
						Weld Fillet	As Welded	8,000	55	55
						Weld Fillet	1200° F. (650° C.) 4 hr. AC	9,350	65	over 120
D	0.16	0.78	0.45	2.02	—	Cast Fillet	As Annealed	9,300	72	
						Weld Fillet	As Welded	9,150	29	
						Weld Fillet	1200° F. (650° C.) 1 hr. AC	9,600	63	
H	0.16	0.90	1.11	1.67	—	Cast Fillet	As Annealed	10,500	66	
						Weld Fillet	As Welded	8,700	30	
						Weld Fillet	1200° F. (650° C.) 1 hr. AC	8,700	53	
L	0.15	1.08	0.98	1.77	—	Cast Fillet	As Annealed	9,750	60	66
						Weld Fillet	As Welded	8,150	29	29
						Weld Fillet	1200° F. (650° C.) 4 hr. AC	9,500	65	75
F	0.20	1.12	1.12	1.95	—	Cast Fillet	As Annealed	11,250	63	
						Weld Fillet	As Welded	8,950	20	
						Weld Fillet	1200° F. (650° C.) 1 hr. AC	10,000	45	
J	0.24	1.12	1.05	1.70	—	Cast Fillet	As Annealed	11,500	71	75
						Weld Fillet	As Welded	7,100	20	20
						Weld Fillet	1200° F. (650° C.) 4 hr. AC	8,500	36	36

aging treatment for copper steel castings is 900° F. (480° C.) for 5 hr., which is midway between the two extremes shown in the curves.

This aging time and temperature are not very critical, as the curves are fairly flat at maximum strength values, and varying the time at temperature an hour more or less, or the temperature by ± 25° F. (15° C.) will not appreciably affect the properties obtained. With castings of light section, the upper limit of aging can be used due to the fact that thermal equilibrium in the casting is reached quickly, while for heavy sections more uniform properties throughout the casting are obtained by aging at a lower temperature such as 870° F. (465° C.) for 8 hr.

Copper Steel in Heavy Sections. An advantage of the copper-iron precipitation hardening system is that drastic quenching is unnecessary prior to aging. Cast cylindrical sections up to 8 in. in diameter were found to respond to the aging treatment after air cooling. The strength and hardness at the centers of 2, 4, 6, and 8-in. sections are shown graphically in Fig. 12. As the section size increases, the improvement in strength on aging is reduced, because, since the cooling rate from the solution temperature is slower, less copper is retained in supersaturated solution.

Nevertheless, with these steels, the strength at the center of an 8-in. section can be increased by 10,000 psi. simply by aging after normalizing. The 2-in. cylinders increased in strength about 18,000 psi. after aging. Hardness surveys across each of the sections tested showed the hardness to be quite uniform although the hardness level became lower as the section size increased.

Cylinders Water Quenched

A series of these cylinders was also water quenched from 1700° F. (930° C.) and subjected to the aging treatment. Hardness surveys were then made across disks cut from these cylinders in both the "as quenched" and in the quenched and aged condition. The hardness across these sections after quenching was not as uniform as it was after normalizing, but decreased from the surface to the center.

In Fig. 13 the hardness at the center and surface of these cylinders is shown before and after aging. Whereas after air cooling from the solution temperature the aging effect diminished as the section size increased, when these sections are water quenched the aging effect becomes more pronounced as the section size increases to 8-in. diam.

In the small sections a certain amount of hardening is present upon quenching due to the carbon present and, when these steels are aged, the increase in strength due to aging is superimposed upon the softening due to tempering. The large 8-in. section, although water quenched, cools at a rate which is comparable

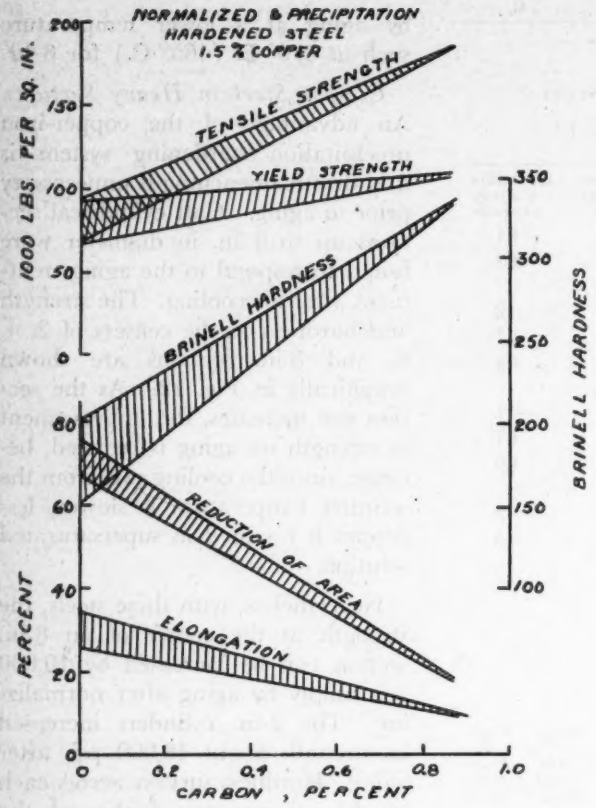


Fig. 10—Magnitude and direction of property changes brought about by precipitation hardening 1.5 per cent copper steels of varying carbon contents. (Williams and Lorig, "Metals and Alloys," March, 1936.)

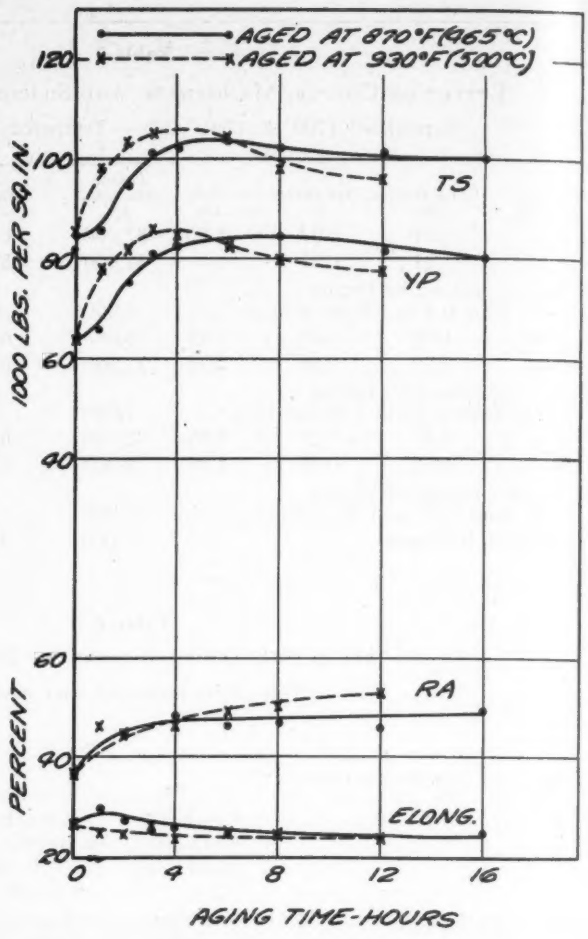


Fig. 11—Effect of aging time and temperature on steel of—C, 0.14; Mn, 0.56; Cu, 1.36; Si, 0.99.

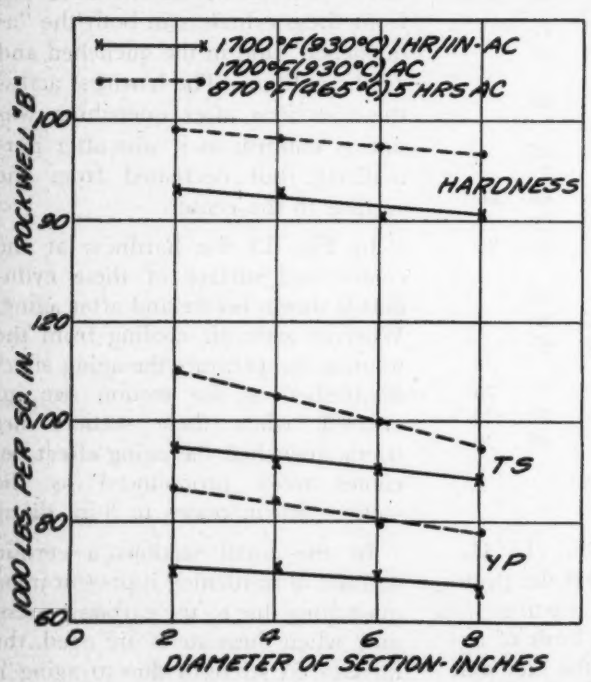


Fig. 12—Effect of aging on large sections after normalizing treatment. Composition, per cent—C, 0.16; Mn, 1.02; Si, 1.09; Cu, 1.49.

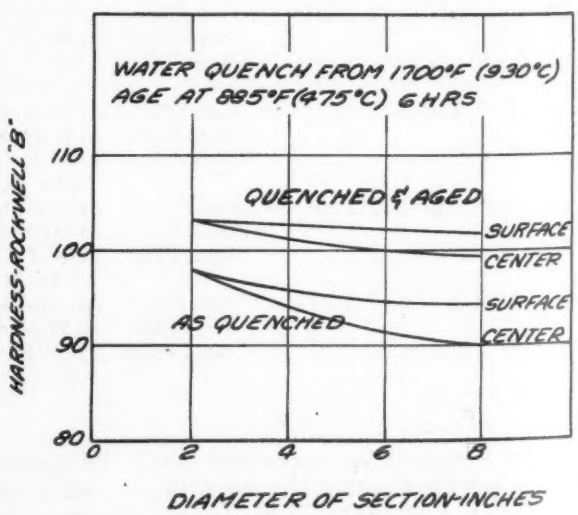


Fig. 13—Effect of aging on large sections after water quenching treatment. C, 0.14; Mn, 0.80; Si, 1.31; Cu, 1.48 per cent.

to the cooling rate of an air cooled one-in. section.

The hardness at the center of the 2-in. section increased by 5 points on the Rockwell B Scale, whereas hardness at the center of the 8-in. section increased 10 points. When strength in large sections is desired it can be secured economically by quenching a copper steel and aging, rather than by obtaining sufficient hardenabiilty by means of more expensive alloying elements.

Fluidity of Copper Steels. Figure 14 shows fluidity curves of a copper silicon steel and also of a plain carbon steel as measured in the spiral fluidity mold developed at the Naval Research Laboratory[18]. For any pouring temperature the copper silicon steel flows from 6 to 8 in. farther in the spiral fluidity mold than does the plain carbon steel.

Low Temperature Properties. It was thought that these steels would be desirable for use in ships' castings because their high yield strength would make it possible to design on a higher strength basis with a corresponding weight reduction of the castings. Thus it would be necessary that they exhibit good properties at low temperatures.

Impact Tests

Low temperature impact tests were made on a copper steel, and the results are compared with those obtained from a plain carbon and a 2.90 per cent nickel steel which is noted for its low notch-sensitivity at low temperatures. These steels were all normalized and tempered at 1200° F. (650° C.), and contained 0.15 per cent carbon.

The nickel steel, as shown in Fig. 15, is superior in impact resistance at low temperature, but the copper steel is distinctly better than the plain carbon steel. Tempering at 1200° F. (650° C.), which is well above the age-hardening temperature, places the copper steel in its softest condition. Aged copper steels have low impact values, and these steels in the aged condition would undoubtedly show poor impact properties at sub-zero temperatures.

High Temperature Properties. The curves of Fig. 16 show the results of short-time tensile tests made at temperatures as high as 1400° F. (760° C.) with 0.313 in. diameter specimens. All specimens were annealed before testing. A well-insulated furnace was used and temperatures were held within ± 5° F. (3° C.) by means of an accurate controlling pyrometer which was checked regularly with a portable potentiometer.

Temperatures were measured with chromel-alumel thermocouples spot-welded to the specimens. The tests were not started until each specimen had been held at temperature for ½ hr. and the rate of loading was low; at least 5 min. were taken to load each specimen.

Curves Plotted

Stress-strain curves were plotted from the loads indicated by the testing machine and extensions read with an optical extensometer accurate to 0.0002 in. Platinum reference lines were used on the specimen at a gauge length of 1¼ in. and sightings were taken through quartz-covered slits in the furnace.

It was thought that, since molybdenum has been used to improve the high temperature characteristics of carbon steel, it might act similarly in copper steels. This would be desirable because of the greater inherent strength of copper steels and because of their good behavior in the foundry.

Each point on the curves of Fig. 16 represents results from two tests which did not vary by more than 5 per cent. The copper steel shows consistently higher proportional limits and tensile strengths than does the carbon-molybdenum steel. The coper-molybdenum steel has the highest tensile strength of the three steels at all temperatures, but the proportional limit is initially lower than it is for the plain copper steel.

Indication of Tests

Although these tests serve only a superficial purpose, they do indicate that copper-molybdenum steels have promise for service at moderately high temperatures. Their high proportional limits and tensile strengths make them worthy of consideration for service at temperatures below 750° F. (400° C.).

Scaling Resistance of Copper Steels. The beneficial effects of small amounts of copper for increasing the resistance of steel to atmospheric corrosion are well known. The curves of Fig. 17 show that the presence of copper in steel also increases its resistance to oxidation in furnace atmospheres during heat treatment. These results were obtained on small machined specimens of identical shape; each specimen weighed slightly less than one lb. The specimens were weighed in previously ignited crucibles and placed in a furnace with normal atmosphere at 1600° F. (870° C.).

After an exposure of one hr. the pieces were cooled in a dessicator and weighed. Without removing the oxide scale, heating, cooling, and weighing were repeated several times to obtain the data shown in Fig. 17. The increases in weight of the specimens are due to the oxygen which combined with the iron to form the scale and may be taken as a measure of the relative amounts of scaling on carbon steel, carbon-molybdenum steel, and copper steel.

The copper steel showed a consistently greater resistance to oxidation than did the carbon and carbon-molybdenum steels, which oxidized at about the same rate: An interesting difference in the steels was in the type of scale formed.

Scale Formed

That scale which formed on the carbon and carbon-molybdenum steels blistered and flaked off leaving a fresh surface for further oxidation, while on the copper steel the oxide layer was more dense and tightly adherent. A copper-rich film is left beneath the scale which is extremely resistant to oxidation, and this probably is the greatest factor in preventing scaling of copper steels.

In larger scale tests on sandblasted castings which weighed approximately 5 lb. each, the plain carbon steel gained 1.25 per cent in weight at 1700° F. (930° C.) for 18 hr., while the copper steel gained only 0.96 per cent by weight.

Weldability of Copper Steels. The weldability of copper steels was studied by means of the tee-bend test. In this test two castings were made, as shown in Fig. 18, for each composition tested. One casting was made with square corners at the junction forming the tee, and the other was made with filleted corners. The plates were annealed after casting and a weld bead was laid along each internal corner of the unfilleted plate so that the two plates had the same shape, one with cast fillets and the other with weld fillets.

The plates were then sectioned to

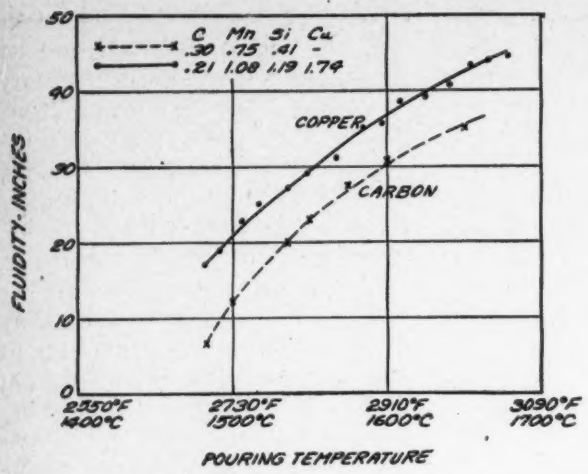


Fig. 14—Fluidity of a plain carbon and a copper steel as measured by fluidity spiral.

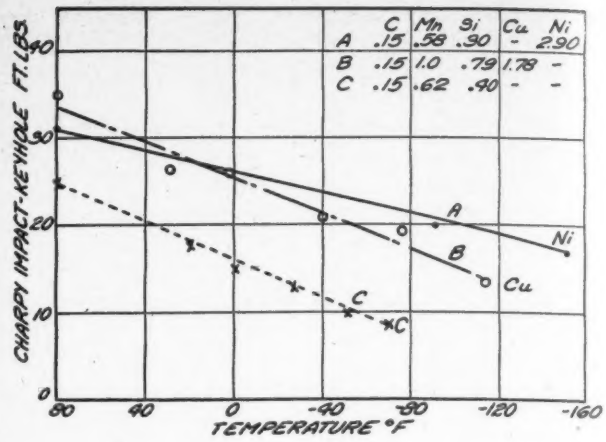


Fig. 15—Low temperature impact properties of plain carbon, nickel and copper steels. Heat treatment—double normalize and temper 1200° F.

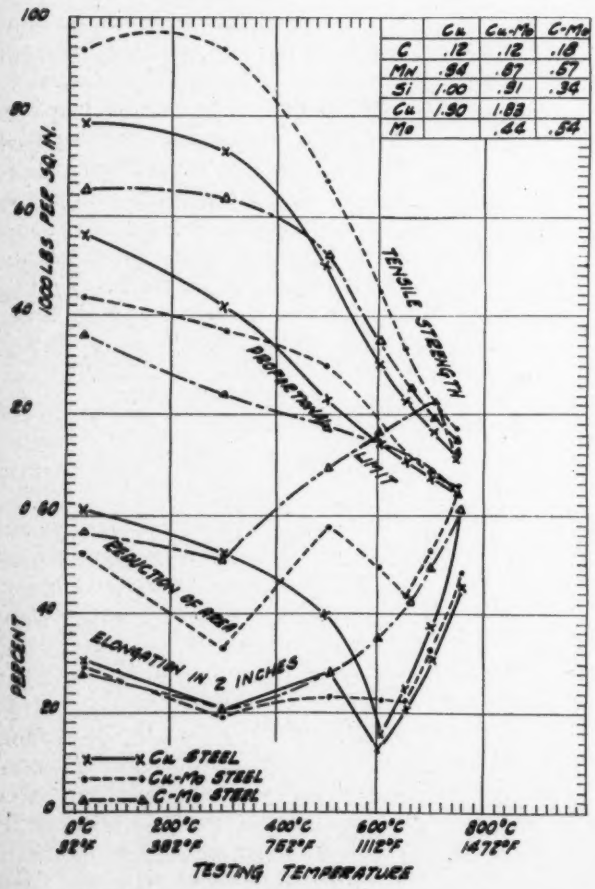


Fig. 16—Quick tensile properties of copper and copper-molybdenum steels after full anneal.

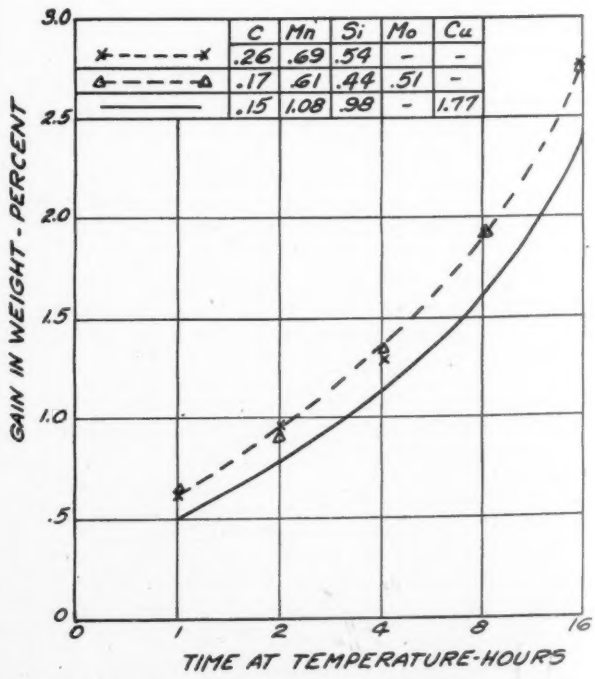


Fig. 17—Gain in weight of three steels due to oxidation in heat treat furnace at 1600° F.

obtain 1¾-in. strips and each strip was tested either in heat treated or "as-welded" condition, with no further machining. By comparing the properties of the welded specimens with those of the cast filleted specimens, the effect of welding on the base metal was determined. The welds were made with E 6010 type of electrode by using a current of 175 amps., an arc voltage of 26, and a speed of travel of 4 in. per min. All variables were automatically controlled.

Each 1¼-in. specimen was tested in the jig, as shown in Fig. 19. The specimen was held securely to prevent shifting and to cause bending to occur uniformly at each fillet as pressure was applied to the back of the specimen by means of the plunger operated by a hydraulic testing machine. The angle through which the specimen was bent at maximum load was measured. This angle is the supplement of the angle made by the legs of the tee.

The results of the tee-bend test are shown in Table 3. The angle at maximum load is generally accepted as a reasonable measure of weldability, and an angle of 45 degrees may be considered to be satisfactory. The results provide a comparison between plain carbon and copper steels.

Copper Steel Weldable

It is indicated that a copper steel containing 0.11 per cent carbon is quite weldable and can be used in the "as-welded" condition if necessary. This steel has an angle at maximum load in the "as-welded" condition of 55 degrees and, by tempering, the ductility of the specimen is raised to that of the annealed specimen with cast fillets.

Table 4

PHYSICAL PROPERTIES OF SOME LOW-CARBON COPPER STEELS IN NORMALIZED AND ANNEALED CONDITION

Heat No.	Composition, per cent C	Mn	Si	Cu	Heat Treatment	Yield Strength, psi.	Tensile Strength, psi.	Elongation, per cent in 2 in.	Reduction of Area, per cent
23	0.12	0.83	0.79	1.85	1706° F. (930° C.) 2 hr. Air Cool	68,500	84,500	26.1	59.6
24	0.12	0.83	1.48	1.85	1706° F. (930° C.) 2 hr. Air Cool	64,000	81,000	26.1	49.6
73	0.11	1.04	1.23	1.74	1742° F. (950°C.) 2 hr. Furnace Cool	64,000	81,000	31.0	56.0
33	0.08	0.77	1.00	1.95	1706° F. (930° C.) 2 hr. Furnace Cool	53,000	71,000	34.4	64.9

Table 5

PHYSICAL PROPERTIES OF WATER QUENCHED STEELS

Steel No.	Draw Temperature, ° F.	° C.	Time, hr.	Yield Strength, psi.	Tensile Strength, psi.	Elongation, per cent in 2 in.	Reduction of Area, per cent	Izod, ft.-lb.	Brinell Hardness No.
1	1000	538	20	102,000	116,500	17.2	40.4	27	245
1	900	482	20	106,000	122,000	19.6	41.6	26	270
1	800	427	7	138,000	155,000	16.0	32.3	9	340
1	650	343	14	145,000	156,000	13.5	32.0	9	350
3	1200	650	7	117,000	127,000	18.5	49.2	32	255
3	1150	621	7	112,000	123,000	20.3	49.2	32	255
3	1075	580	7	151,000	158,000	16.4	43.0	20	—
3	1000	538	20	155,000	163,000	16.4	42.6	18	330
3	900	482	20	160,000	166,500	14.1	38.8	12	340
3	900	482	1	182,000	185,000	9.4	30.3	—	370
5	1075	580	7	111,000	126,000	17.6	39.5	29	255
5	1000	538	20	119,000	133,000	16.4	37.6	17	275
5	900	482	20	127,000	139,000	15.2	36.2	19	295
5	800	427	7	160,000	173,000	12.5	28.0	11	360

	Composition, per cent C	Mn	Si	Cu	Mo
1	0.17	0.92	1.14	1.94	—
3	0.15	0.90	1.13	1.75	0.54
5	0.25	0.91	1.19	1.71	—

Heat Treatment (all specimens)	Temperature ° F.	° C.	Time, hr.
Homogenize	2000	1093	7
Normalize	1700	930	2
Water Quench.....	1650	900	1

When the carbon in copper steels is 0.15 or 0.16 per cent, as in samples *D, H,* and *L,* it becomes necessary to stress relieve after welding in order to obtain satisfactory ductility. As welded, these steels have an angle at maximum load of about 30 degrees but, by stress relieving, it becomes approximately 60 degrees.

A 0.20 per cent carbon, copper steel can be restored to a ductility of 45 degrees bend by tempering at 1200° F. (650° C.) for one hr., but in the 0.24 per cent carbon steel the ductility of the welded plate was not restored to a suitable value even after tempering at 1200° F. (650° C.) for 4 hrs. The steels used in these tests contained more manganese and silicon than is normally used in cast steel, which would tend to impair the weldability of the steels due to their effect of increasing the hardenability.

However, it can be definitely concluded from these results, that copper steels containing less than 0.20 per cent carbon can be welded with no deleterious effect if given a stress relief treatment after welding.

Satisfactorily Welded

The fact that copper steels containing approximatly 0.10 per cent carbon can be welded satisfactorily without preheat or postheat becomes significant when it is also realized that remarkable physical properties are obtained from this alloy upon full-annealing or normalizing without any aging treatment whatsoever.

Thus, such a composition can be readily welded at tensile strengths and yield strengths above 70,000 and 50,000 psi., respectively. In Table 4, the physical properties of several steels which have approximately the foregoing composition are listed.

Water Quenched Copper Steels. Table 5 lists some properties of copper steels as quenched and tempered. All tensile blanks were 1x1x4-in. specimens and were heat treated in this form. An excellent combination of strength and ductility is obtained by water quenching and tempering copper and copper-molybdenum steels in one-in. sections, which indicates that these steels may be used in small gears and structural parts requiring yield strengths of over 100,000 psi.

Copper Steels Compared to Plain Carbon Steels. Fig. 20 shows the

range of properties that can be obtained in copper steels without liquid quenching. The lower limits of strength and the upper limits of ductility are the properties in the fully annealed condition; the other limits are the properties after aging to maximum hardness. In between the two extremes mentioned are the properties obtained at varying degrees of aging.

This graph (Fig. 20) indicates the extreme flexibility of copper steels and the excellent properties obtainable. The curves only extend to 0.25 per cent carbon, which is the maximum amount recommended for these steels. The optimum carbon is 0.10 to 0.20 per cent.

Obtainable Properties

Figure 21 is a graph taken from the *Steel Castings Handbook,* which shows the properties obtainable in plain carbon steels by quenching and tempering. The bands cover a tempering range from 1050-1300° F. (566-704° C.), and the range of carbon content of these steels is from 0.20 to 0.50 per cent. At the extreme left side of the chart the properties of copper steel containing 0.20 per cent carbon have been indicated in the normalized and aged condition.

The tensile strength of air cooled and aged copper steel is equal to that of the quenched and tempered 0.50 per cent carbon steel, and the yield point of the copper steel exceeds the yield point of the quenched and tempered carbon steel by more than 10,000 psi. The reduction of area and the elongation of the copper steel compare favorably with the corresponding properties of the carbon steels.

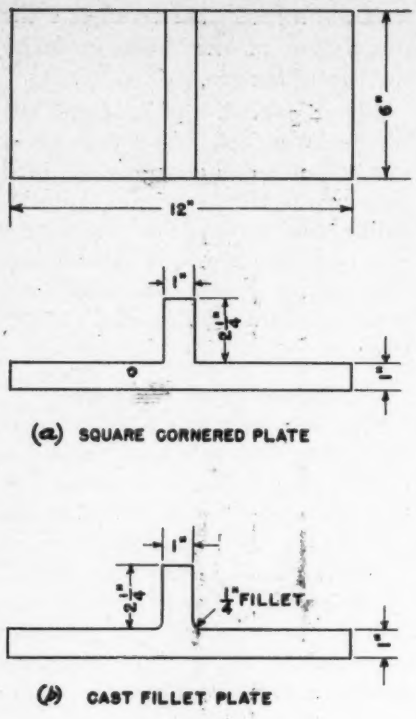
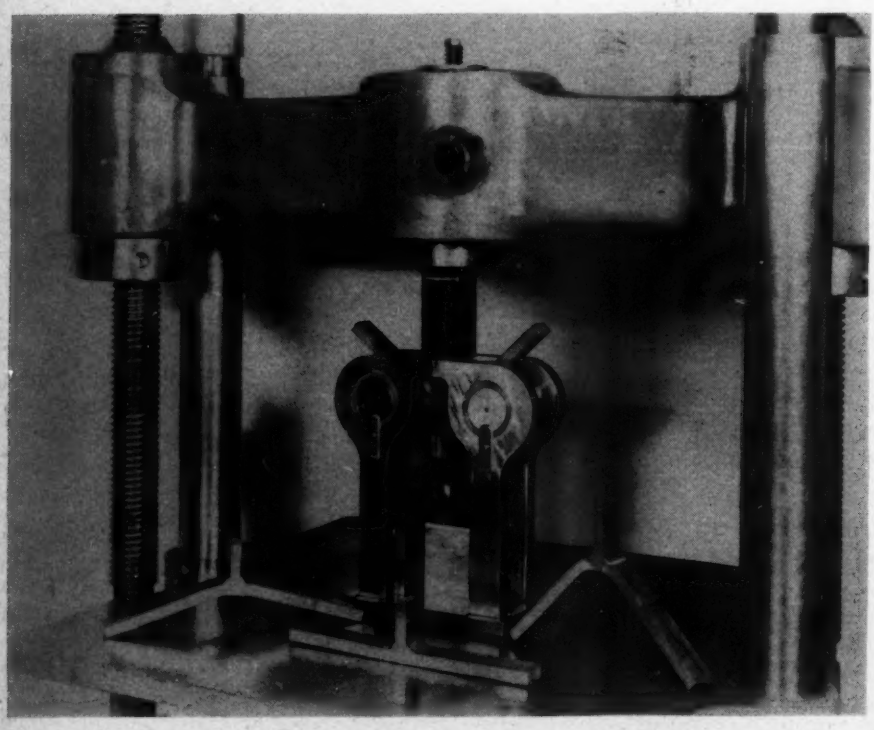


Fig. 18—Views of "Tee-bend" test plates—(A) square cornered plate and (B) cast fillet plate.

Fig. 19—Bending a "Tee-bend" specimen.



Conclusions

Steels containing 1.5 to 2.0 per cent copper, with silicon and manganese contents of approximately 1.0 per cent each, have excellent casting characteristics as proved by spiral fluidity tests and by production casting operations.

With copper steels, it is possible, by using a properly balanced composition and suitable heat treatment, to obtain strength values which can be attained in carbon steels only by raising the carbon content to the upper part of the medium carbon range and fully quenching and tempering.

Precipitation hardened copper cast steels have unusually high yield strength to tensile strength ratios. Such ratios are 0.8 or above as compared to normalized and tempered carbon steels at 0.6 or below, and normalized and tempered alloy steels at 0.6 to 0.7. Quenched and tempered steels have ratios of approximately 0.8, but such steels must be sufficiently alloyed to harden throughout the section being quenched.

By precipitation hardening, almost full strength is developed in copper steels at the center of fairly heavy sections. After normalizing and aging, the tensile strength at the center of an 8 in. diameter cylinder was only 15 per cent less than that at the center of a 2 in. diameter cylinder of the same material which was similarly treated. The corresponding decrease in yield strength was 12 per cent.

Heat Treating

Heat treating for precipitation hardening does not require critical time or temperature control. In the solution treatment, the copper is satisfactorily dissolved by any commercial austenitizing treatment such as is used for annealing, normalizing, or hardening, and is retained sufficiently at all rates of cooling equal to or faster than that which occurs upon air cooling of moderately heavy sections.

Aging for maximum strength requires somewhat closer control of time and temperature. For commercial practice, it is considered advisable to age at 900° F. (480° C.) for 5 hr. so that the danger of overaging is less than is encountered by attempting to age at higher tem-

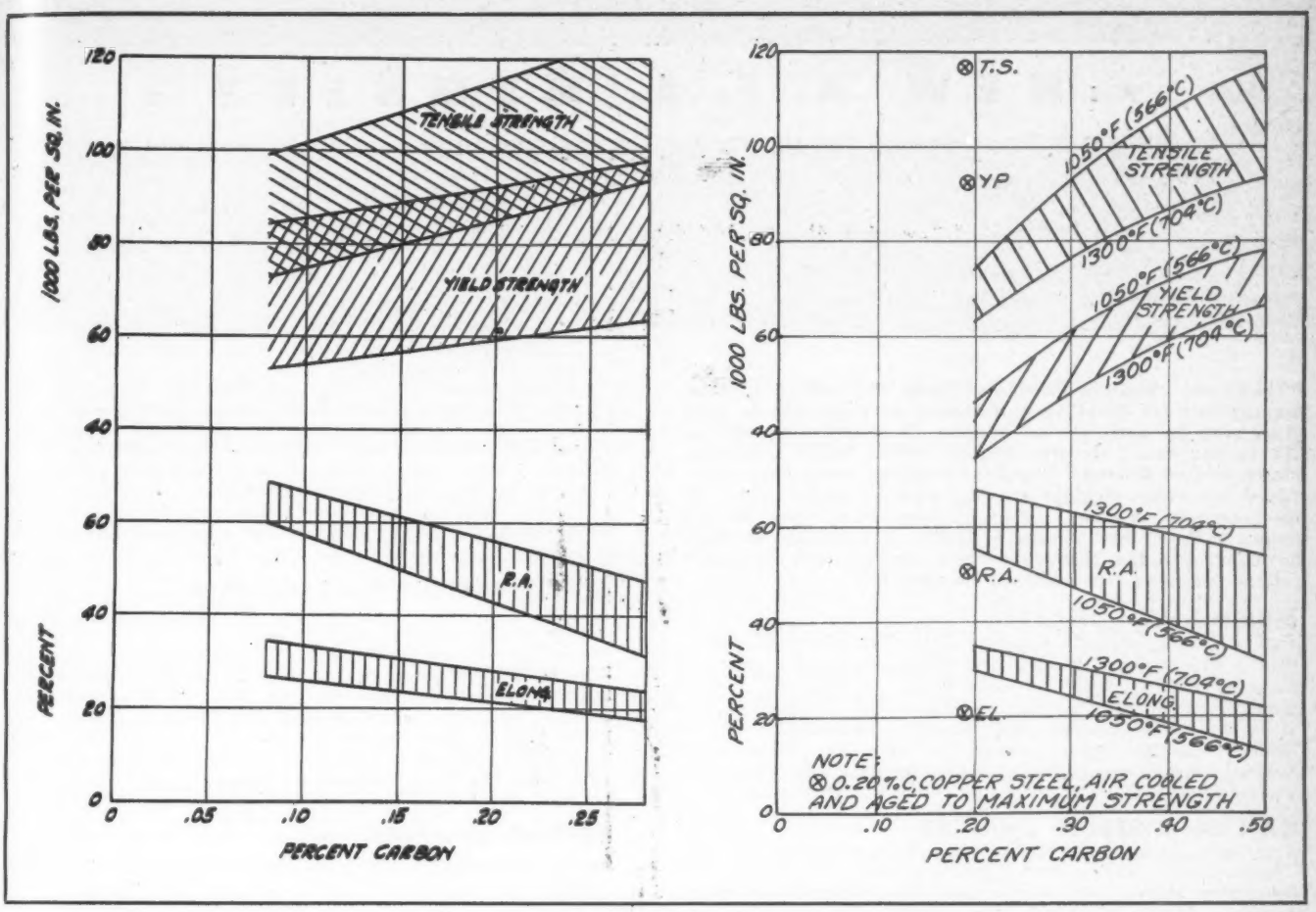


Fig. 20 (left)—Range of properties obtainable in copper steels without liquid quenching. Fig. 21 (right)—Range of properties obtainable in plain carbon steels in water quenched and tempered condition.

peratures for shorter periods of time.

Copper steels can be welded easily. When the carbon content is less than 0.15 per cent, weldments have sufficient ductility to be used in the "as-welded" condition; at approximately 0.10 per cent carbon, these steels have yield points above 50,000 psi. and can be welded without preheating or postheating. Above 0.15 per cent carbon, stress-relieving is necessary for satisfactory ductility.

For purposes of good weldability and development of optimum physical properties in copper cast steels, the carbon content should be low, preferably below 0.20 per cent.

Copper steels have excellent tensile properties at sub-zero temperatures in the normalized, normalized and aged, and normalized and tempered conditions. Likewise, they have less notch sensitivity at low temperatures in the normalized and tempered condition than do carbon steels of the same general composition and heat treatment condition.

It is indicated from short-time tensile tests that copper steels containing molybdenum are potentially useful for high temperature applications. Scaling tests show that copper steels are more resistant to oxidation at high temperatures than are carbon and carbon-molybdenum steels.

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★ NEW A. F. A. MEMBERS ★

(Covering the period from March 15 to April 15)

• Thirty-one chapters have sent in to the National Office the applications of 167 new members on these pages. Last year, over the same period of time, 25 chapters brought in 111 foundrymen. Central Illinois, A.F.A. "baby" chapter, finally evicted Chicago from first position, which they maintained for three straight months, with 17 names including one company member. Northeastern Ohio took second honors with 15 new names, including a company member. However, Chicago hung onto third position with 13 applications including two company memberships.

BIRMINGHAM CHAPTER

Thomas P. Barnefield, Engr., National Cast Iron Pipe Co., Birmingham.
Chas. S. Chisholm, Met., Wheland Co., Chattanooga, Tenn.
Joseph L. Hill, Fdry. Supt., Continental Gin Co., Birmingham.
Blenna H. Lester, Fore., Stockham Pipe Fittings Co., Birmingham.
M. E. Moore, Fore., Stockham Pipe Fittings Co., Birmingham.
Herman Reeves, Fdry. Supt., Stockham Pipe Fittings Co., Birmingham.
Charles L. Snider, Fore., Stockham Pipe Fittings Co., Birmingham.
William J. Vinson, Fore., Stockham Pipe Fittings Co., Birmingham.

CANTON DISTRICT CHAPTER

A. C. Heimann, Journeyman Molder, The Lectromelt Castings Co., Barberton, Ohio.
Robert Hug, Molder, United Engineering & Foundry Co., Canton, Ohio.
Anthony F. Waller, Steel Melter, The Lectromelt Castings Co., Canton, Ohio.

CENTRAL ILLINOIS CHAPTER

H. B. Bennett, Pttnmkr., Midwest Pattern Works, Peoria, Ill.
Howard Bergman, Pttnmkr., Midwest Pattern Works, Peoria, Ill.
B. L. Bevis, Fdry. Instr., Caterpillar Tractor Co., Peoria, Ill.
C. M. Boheneck, Foreman, Caterpillar Tractor Co., Peoria, Ill.
Melvin Bradney, Pttnmkr., Midwest Pattern Works, Peoria, Ill.
Jack Danner, Pttnmkr., Midwest Pattern Works, Peoria, Ill.
Ellsworth F. Hill, Fore., Caterpillar Tractor Co., Peoria, Ill.
Thomas T. McCarthy, Office Mgr., South Side Foundry Co., Peoria, Ill.
Bernard Meagher, Pttmkr. Apprentice, Midwest Pattern Works, Peoria, Ill.
***Midwest Pattern Works, Peoria, Ill. (V. W. A'Hearn, Owner).**
H. A. Polderman, Met. & Mech. Engr., Caterpillar Tractor Co., Peoria, Ill.
Henry W. Ringger, President, Gridley Farm Tool Co., Gridley, Ill.
George H. Rockwell, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
George W. Schuller, Foreman, Caterpillar Tractor Co., Peoria, Ill.
C. Turner, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
John Vance, Pttnmkr. Appr., Midwest Pattern Works, Peoria, Ill.
Fred W. Wagner, Caterpillar Tractor Co., Peoria, Ill.

CENTRAL INDIANA CHAPTER

John H. Hock, Engr., Chicago Retort & Fire Brick Co., Chicago.
Richard E. Kephart, G. M. Student, Allison Div., G.M.C., Indianapolis.

CENTRAL NEW YORK CHAPTER

J. M. Johnson, Fdry. Supt., Genesee Foundry Co. Inc., Syracuse, N. Y.
C. L. Sims, Sims Matchplate Co., Syracuse, N. Y.

CENTRAL OHIO CHAPTER

***Lancaster Foundry Corp., Lancaster, Ohio (A. K. Lucas, Supt.).**
M. L. Wimer, Lancaster Foundry Corp., Lancaster, Ohio.

CHESAPEAKE CHAPTER

T. T. Alverson, Sales Engr., American Foundry Equipment Co., Mishawaka, Ind.
Raleigh C. Mays, Jr., Fdry. Supt., Lynchburg Foundry Co., Lynchburg, Va.

CHICAGO CHAPTER

D. M. Boston, Vierling Steel Works, Chicago.
***Benj. Harris & Co., Chicago Heights, Ill. (Nathan Harris, Treas.).**
W. W. Hecht, Supt. Power Div., International Harvester Co., Indianapolis.
M. F. Herder, Pttn. Storage Fore., Calumet Steel Castings Corp., Hammond, Ind.
W. James Herder, Continental Foundry & Machine Co., E. Chicago, Ind.
Clarence E. Holsapple, Pttnmkr. & Tool Designer, Mattoon, Ill.
E. L. LaGrelius, Res. Met., American Steel Foundries, E. Chicago, Ind.
Charles E. Law, Chemist, Allied Steel Castings Co., Harvey, Ill.
Timothy D. Nulty, Manager, Scientific Cast Products Corp., Chicago.
Homer W. Northrup, Engr., International Nickel Co., Chicago.
J. T. Richey, Sales Engr., Great Lakes Carbon Corp., Niagara Falls, N. Y.
***Smeeth-Harwood Co., Stanley A. Burd, Supt., Chicago.**
Honore P. Tuman, Sales Dept., Sivyer Steel Casting Co., Chicago.

CINCINNATI DISTRICT CHAPTER

Joseph A. Bailey, Supt. of Finishing, Dayton Malleable Iron Co., Dayton, Ohio.
Benson Davis, Fdry. Supt., Burnham Boiler Corp., Zanesville, Ohio.
Raymond M. Dudley, Fore., Dayton Malleable Iron Co., Dayton, Ohio.
Basil N. Greenlaw, Plant Mgr., Burnham Boiler Corp., Zanesville, Ohio.
Arthur L. Grim, Supt. of Fdry., Dayton Malleable Iron Co., Dayton, Ohio.
Harold S. Hyatt, Chief Insp., Dayton Malleable Iron Co., Dayton, Ohio.
R. C. Roll, Purch. Agent., Burnham Boiler Corp., Zanesville, Ohio.
John Seibel, Fore., Dayton Malleable Iron Co., Dayton, Ohio.
Henry A. Shaner, Fore., Dayton Malleable Iron Co., Dayton, Ohio.

DETROIT CHAPTER

George H. Bascom, Sand Dept. Fore., Albion Malleable Iron Co., Albion, Mich.
Norman A. Cobb, Fdry. Supt., Detroit Brass & Malleable Works, Detroit.
A. E. Codney, Asst. Supt., Aluminum Co. of America, Detroit.
Leonard W. Czarnecki, Student, General Motors Institute, Flint, Mich.
Charles H. Johnston, Supv., Wilson Foundry & Machine Co., Pontiac, Mich.
Dean E. Shiels, Fore. Met. Control, Packard Motor Car Co., Detroit.
Robert D. Wiley, Service Engr., Master Tool Co., Inc., Cleveland.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Raoul Bazinet, Molder, Northern Foundry Co., Pont Viau, Que.
Geo. H. Gamble, Fore., Canadian Car & Foundry Co., Ltd., Montreal, Que.
Milfred S. Williams, Fore., Canadian Car & Foundry Co. Ltd., Montreal, Que.

METROPOLITAN CHAPTER

***Burnham Boiler Corp., Irvington-On-Hudson, N. Y.**
Robert S. Burpo, Jr., Assoc. Editor, *Materials & Methods*, N. Y.
William E. Cavanagh, Met. Engr., Alloy Steel Products Co., Newark, N. J.
***Brazilian National Steel Co., New York.**
Philip F. Gray, Jr., Whiting Corp., Harvey, Ill.
V. S. Kharitonov, M. E., Government Purchasing Commission in U. S. A., Washington, D. C.
Raymond A. Martinson, American Brake Shoe Co., Mahwah, N. J.
Herman K. Schoenheiter, Special Appr., American Brake Shoe Co., Mahwah, N. J.

MEXICO CITY CHAPTER

***Hierro Maleable De Mexico, S. de R.L.Y.C.V. San Pedro De Los Pinos, Mexico City.**
Ing. Marcos Braslavsky, Fundicion Mabras, Mixeco, D.F. (Owner).
Ing. Marcos Braslavsky, Fundicion Mabras, Mexico, D.F. (Owner).
Luis Castillo, Cop. Fundidora y Laminadora, Chapultepec, Mexico, D.F.
***Coperatira Fundirora y Laminadora, Chapultepec, Mexico, D. F.**
***Cia Fundidora de Fierro y Acoro de Monterrey, S.A. Mexico.**
Francisco Fernandex, Mgr. Fdry. Div. Cia Fundidora de Fierro y Accoro de Monterrey, S.A. Mexico.
Carl E. L'Brien, Mgr. Mexico City Office, National Carbon-Everready S.A., Mexico.
Ing. Julio Natalio Sanchez, Cop. Fundidora y Laminadora, Chapultepec, Mexico, D.F.

MICHIANA CHAPTER

***Robert M. Cotter, Prod. Mgr., The LaBour Co., Inc., Elkhart, Ind.**
***Nylen Products Co., St. Joseph, Mich. (John A. Nylen, Pres.).**

NORTHEASTERN OHIO CHAPTER

Frank L. Bulen, Mold. Fore., Forest City Foundries Co., Cleveland.
***The Frank L. Crobaugh Co., Cleveland (O. M. Beach, Pres.-Treas.).**
Robert J. Feltes, Ass't Mgr., Service Pattern Works, Cleveland.

*Company Members.

Henry M. Frechette, Coremaker Appr., Ohio Foundry Co., Cleveland.
Robert G. Heintz, Partner, Pattern Castings Co., Cleveland.
Sydney L. Johnson, Time Study Eng., Lake City Malleable Co., Cleveland.
Joseph Knies, Gen. Fdry. Fore., Lake City Malleable Co., Ashtabula, Ohio.
Alex Kuligoski, Core Fore., Lake City Malleable Co., Ashtabula, Ohio.
John Nestor, Fore., National Malleable & Steel Castings Co., Cleveland.
Glen Nichols, Refr. Engr., Lake City Malleable Co., Cleveland.
Charles L. Plant, Supt., Standard Alloy Co., Cleveland.
Lawrence E. Rayel, Salesman, Werner G. Smith Co., Cleveland.
Michael Rowinski, Core Fore., Lake City Malleable Co., Ashtabula, Ohio.
Henry R. Tisdale, Fore., Service Pattern Works, Cleveland.
M. L. Wimer, General Implement Co., Cleveland.

NORTHERN CALIFORNIA CHAPTER

Fred Angella, Fore., H. C. Macaulay Foundry Co., Berkeley, Calif.
Ward Chamberlain, Balfour, Guthrie & Co. Ltd., San Francisco.
E. L. Fetters, Molder, Mare Island Ship Yard, Mare Island, Calif.
Robert Edward Perkins, Mgr., L. G. Perkins Foundry, Fresno, Calif.
Robert B. Prock, Salesman, Atkins, Kroll & Co., San Francisco.
Edward S. Taylor, Pacific Steel Casting Co., Berkeley, Calif.

NO. ILLINOIS-SO. WISCONSIN CHAPTER

O. T. Holum, Greenlee Bros. & Co., Rockford, Ill.
*Walworth Foundries, Inc., Walworth, Wis. (Carl T. Miller, Pres.).

NORTHWESTERN PENNSYLVANIA CHAPTER

Richard G. Miller, Open-Hearth Met., American Locomotive Co., Latrobe, Pa.
Eugene B. O'Connor, Distr. Sls. Mgr., Peninsular Grinding Wheel Co., Detroit.
Bryan Worden, Fdry. Fore., Erie Malleable Iron Co., Erie, Pa.

ONTARIO CHAPTER

Chas. Heward, Sales Mgr., Standard Fuels Ltd., Toronto, Ont.
F. A. Wells, Fdry. Fore., Canadian General Electric Co. Ltd., Peterborough, Ont.
Richard N. West, Met., Sully Brass Foundry Ltd., Long Branch, Ont.

OREGON CHAPTER

R. C. Aungst, Met., Oregon Brass Works, Portland, Ore.
Harry Dahlberg, Ass't. Prof. of Industrial Arts, Oregon State College, Corvallis, Ore.
Harold A. Story, Supt., Oregon Brass Works, Portland, Ore.

PHILADELPHIA CHAPTER

Clifton S. Merkert, Met., Link Belt Co., Olney Foundry Div., Philadelphia.
Dan Nagurny, Molder, Modern Brass Co., Philadelphia.
*The Savill Co., Philadelphia (Arthur M. Fischman, Pres.).
Douglas J. Taylor, Engr., Harbison-Walker Refractories Co., Pittsburgh, Pa.

QUAD CITY CHAPTER

Albert H. Discher, Elec. Supt., Ordnance Steel Foundry Co., Bettendorf, Iowa.
Floyd D. Holben, Core Rm. Fore., C. S. Humphrey Co., Moline, Ill.
*Kewanee Boiler Corp., Kewanee, Ill. (W. B. Russell, V. P.).
B. A. Kinnamon, Fdry. Fore., Kewanee Boiler Corp., Kewanee, Ill.
*Maytag Co., Newton, Iowa (L. C. McAnly, Fact. Mgr.).
H. L. Nuding, Fdry. Supt., Kewanee Boiler Corp., Kewanee, Ill.
Roy Ray, Supt. Clean. Dept., Ordnance Steel Foundry Co., Bettendorf, Iowa.
R. H. Somers, Gen. Supt., Kewanee Boiler Corp., Kewanee, Ill.

SAGINAW VALLEY CHAPTER

Donald J. Christensen, Student, General Motors Institute, Flint, Mich.
Russell F. Dent, Midland Iron Works, Midland, Mich.
Wilford C. Dent, Midland Iron Works, Midland, Mich.
F. D. Haskins, Instr., General Motors Institute, Flint, Mich.
F. James McDonald, Engr., Saginaw Malleable Iron Div., G.M.C., Saginaw, Mich.

ST. LOUIS DISTRICT CHAPTER

Wm. N. Chivvis, Prairie Brass & Metal Co., Kansas City, Mo.
Gayle Eihausen, Partner, Alton Iron Works, E. Alton, Ill.
*Hillsboro Foundry Co., Inc., Hillsboro, Ill.
*Midland Metal Mfg. Co., Kansas City, Mo. (E. C. Buckles, V. P.).
E. P. O'Neal, Engr.-Mgr., Arkansas Machine Specialty, Hope, Ark.
Hardy G. Wells, Sales, Miller & Co., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

John C. Beuse, Owner, John C. Beuse Patterns, Los Angeles.
Jack Campbell, Western Mgr., Edw. J. Christiansen Co., Chicago.
George B. Davis, Supt., Rogers Pattern & Foundry, Los Angeles.
Edward C. Hammett, Owner, Power Tool Supply, Los Angeles.
Wm. F. Hedtke, Fore., G-B Brass & Aluminum Foundry Inc., Los Angeles.
Arthur Holmberg, Owner, Superior Pattern Works, Los Angeles.
C. C. Woolsey, Jr., Met., U.S. Naval Ordnance Test Station, Pasadena, Calif.

TEXAS CHAPTER

Barton W. D. Cordell, Sales Repr., Texas Steel Co., Ft. Worth.
H. L. Shepard, Salesman, National Carbon Co., Inc., Dallas.
C. V. Smith, Jr., Sales Repr., Texas Steel Co., Ft. Worth.

TOLEDO CHAPTER

John Cauffiel, Owner, St. Clair Bronze & Aluminum Co., Toledo, Ohio.
Floyd Ensign, Multi Cast Corp., Wauseon, Ohio.

TWIN CITY CHAPTER

Geo. W. Cheney, Owner, Cheney Foundry, Minneapolis, Minn.
Nick Eichhof, C. R. Foreman, Paul Pufahl & Son Foundry, Minneapolis, Minn.
Mark L. Marino, Sales Engr., Chicago Retort & Fire Brick Co., Chicago.

WESTERN MICHIGAN CHAPTER

Walter Lack, Supv. Trainee, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Jerry A. McCray, Melt. Supv., Sealed Power Co., Muskegon Heights, Mich.

WESTERN NEW YORK CHAPTER

Ray M. Walter, Buffalo Pattern Works, Buffalo, N. Y.

WISCONSIN CHAPTER

Wilbur C. Blott, Met., Allis Chalmers Mfg. Co., Milwaukee.
Chas. F. Dombrowskin, Owner, Waupaca Foundry, Waupaca, Wis.
Elmer J. Gorskey, Fore., Koehring (Foundry Div.), Milwaukee.
Elmer F. Helminiak, Allis Chalmers Mfg. Co., Milwaukee.
Howard Place, Time Study Fore., Allis Chalmers Mfg. Co., West Allis, Wis.
Edward Radasevich, Ass't. Fdry. Met., International Harvester Co., Milwaukee.
Harold E. Richards, Lab. Tech., Allis Chalmers Mfg. Co., West Allis, Wis.

OUTSIDE OF CHAPTER

James L. Higson, Supt., Western Foundry, Denver, Colo.
James Rothwell, Prop., Rothwell Brass Foundry, Lonsdale, R. I.

Brazil

Jean Duvernoy, Gen. Mgr., Companhia de Ferro Maleavel, Rio de Janeiro.
Mauricio Martins Siqueira, Sao Paulo.

Denmark

Jul. Gjellerups Tekniske Boghandel, Kobenhavn K.

France

Robert Boutigny, Chief Engr., Societe Stein & Roubaix, Paris.
Guy Henon, Director, Centre de Recherches de Fonderie, Paris.
Fernand Modro, Fdry. Mgr., 51 Rue Vauban, Roubaix-Nord.

India

J. S. Rangaswamy, B. Sc. (Met.), Cooper Engineering Ltd., Presidency.

Norway

Norges Tekniske Hogskole, Trandheim.
Hans Jorgen Schwarts, Engr., Finnmarkskontoret, Harstad.
Ingenior Sissener, c/o Myhrens Verksted, Bentsbrogt, Oslo.
Ingenior Sissener, Jernbanetorget 4, Oslo.

San Salvador

Ernest J. Degenhart, Mgr., Compania Fundicion Electrica.

South Africa

D. T. Greenhorn, Fdry. Mgr., Messrs. Stewarts & Loyds of South Africa, Ltd.

Sweden

K. H. Alvar Huldt, Mgr. & G. S. Domnarfvet Steel & Iron Works, Domnartvet.

*Company Members.

Human Factor Study Is Released

SETTING FORTH practices of 39 companies that have developed training programs, a study on "Training Supervisors in Human Relations" has been issued by the Policyholders Service Bureau, Metropolitan Life Insurance Co., One Madison Ave., New York 10.

Designed to assist business organizations in developing supervisory skills among personnel, and available in limited supply to company executives, the report outlines initial steps in setting up a training program; and analyzes types of courses given, their relationship to other forms of training, duration of program and certain techniques of procedure.

Appended to the study are a training program proposal, an outline and a case study.

FOUNDRY PERSONALITIES

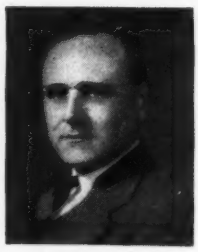
William B. Given, Jr., president, American Brake Shoe Co., has announced contract by the firm to purchase Progressive Foundry Works, Inc., Rochester, N. Y., subject to approval of stockholders of the latter organization. The Progressive company's facilities will be operated as a division of American Brake Shoe, under direction of **W. T. Kelly, Jr.,** with **Howard S. Van Billiard,** president, remaining as manager.

L. B. Neumiller, president, Caterpillar Tractor Co., Peoria, Ill., announces the largest expansion program in the history of the firm. Scheduled to be carried out progressively so that production can be increased as soon as possible, the program will enlarge by 50 per cent the floor area of the plant.

W. S. Davis, Jr., vice-president, Penola, Inc., announces that the firm, which manufactures "Penolyn" Core Oils, has closed its Pittsburgh office and moved to new quarters in the La Salle - Wacker Building, 221 N. La Salle St., Chicago 1.

Joseph L. Dostal, formerly vice-president and general manager, foundry division, Eaton Mfg. Co., Detroit, has assumed the position of general manager, Dostal Per-Mold Foundry Co., a new concern which has purchased the Die Typing Corp. plant, Pontiac, Mich. Mr. Dostal has announced that the new firm will manufacture gray iron castings for automotive, refrigerator and home appliance industries. Associated with the undertaking are **J. G. McIntosh,** attorney, and **J. A. McIntosh,** president, McIntosh Stamping Corp.

C. J. Amick, formerly vice-president and general manager, Century Metalcraft Corp., Los Angeles; **E. D. Amick,** who has been associated with his father, C. J. Amick; and **R. M. Allan,** who has served as president and general manager, A & F Aluminum Products Co., Los Angeles, are principals in the formation of **Triple A Metalcraft Corp.,** Los Angeles, a new firm which takes over plant and production facilities of the A & F company. A. J. Amick assumes the position of president and general manager, and Mr. Allan that of vice-president, of the new concern. Among the directors are: **C. R. Fleishman,** president, Bayer Co., Los Angeles; **L. F. Mulherin, R. L. Shoemaker** and **H. J. Wehrung.**



W. T. Kelly, Jr.

H. F. Anderson, Percival Parsons and **William Anderson,** all formerly associated with Pontiac Foundry & Machine Co., Pontiac, Mich., as, respectively, superintendent, purchasing agent and molder, have purchased American Foundry & Pattern Co., Pontiac, from **Fred T. Holland.** The American company produces non-ferrous castings.

A. C. Waters, managing director, Hadfields Steel Works, Ltd., and Hadfields (Australia) Pty., Ltd., Sydney, Australia, was a recent visitor to the A.F.A. National Office. Mr. Waters and his firm have been members of A.F.A. for some years. Following arrival at St. Johns, Newfoundland, recently, Mr. Waters attended a meeting of the Eastern Canada and Newfoundland chapter before coming on to this country to study American steel foundry methods.

Cabot & Co., Inc., advertising firm, announces removal to new offices in the Renshaw Building, Pittsburgh 22.

Dr. N. E. Woldman

R. E. Ward

R. E. Ward, Chairman, A.F.A. Aluminum and Magnesium Division, has been appointed chief metallurgical engineer, Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., succeeding **Dr. N. E. Woldman,** who has established a consultation service. Dr. Woldman is a former Chairman of the Aluminum and Magnesium Division.

J. A. Havnen, discharged from military service where he served in an engineering boat and shore unit, has joined Flour City Ornamental Iron Co., Minneapolis, as technical supervisor of the non-ferrous foundry. Mr. Havnen was formerly associated with Lynchburg Foundry Co., Lynchburg, Va.

Robert D. Hand and **Alvin H. Berndt** have joined the staff of National Founders Association, **L. E. Roark,** executive vice-president of the association, has announced. Mr. Hand, an engineering graduate of Purdue University, West Lafayette, Ind., will specialize in technical subjects; and Mr. Berndt, who holds degrees from the University of Illinois, Urbana, and John Marshall Law School, Chicago, will specialize in legal matters, and will be available for regional membership meetings and public relations work.

C. C. Hermann has been appointed special sales representative in Indiana, Michigan, Ohio, western New York and western Pennsylvania for the "Hydro-Clone" line of dust collector and spark suppressor equipment, manufactured

(Concluded on Page 105)

★ CHAPTER ACTIVITIES ★

news

Western Michigan

R. W. Hathaway
Cadillac Malleable Iron Co.
Chapter Director

FOUNDRY FUTURES for young men held the spotlight as the Western Michigan A.F.A. chapter met April 11 at Fountain Street Baptist Church, Grand Rapids, Mich., with invitations extended to educators and students of the area to hear two outstanding speakers, C. J. Freund, Dean of the Engineering School, University of Detroit, and Ralph L. Lee, Employee Cooperation Staff, General Motors Corp., Detroit.

Discussing "The Future of the Foundry for a Young Man," Mr. Freund, member of the Advisory Committee, A.F.A. Technical Development Program, highlighted three factors contributing to the bright prospects of such a career: (1) There are more relative opportunities in the foundry than in any other industry; (2) vast amounts of research remain to be done; and (3) such research will be followed by prosperity.

Topic of Mr. Lee was "Romance in the Foundry," and this discussion held the interest of foundrymen, students and guests.

St. Louis District

L. H. Horneyer
Industrial Specialties
Chapter Secretary-Treasurer

ELECTION of officers and directors for the coming year, following amendment of chapter constitution and by-laws to provide separate offices of Treasurer and Secretary, in order that mounting duties might be performed suitably, occupied members of the St. Louis District A.F.A. chapter meeting April 11 at the DeSoto Hotel, St. Louis.

Chosen to lead the chapter in the next year were:

Chairman, Roland Leisk, American Steel Foundries, East St. Louis, Ill.

Vice-Chairman, Norman Peukert, Carondelet Foundry Co., St. Louis.

Secretary, Robert Wood, M. W. Warren Coke Co., St. Louis.

Treasurer, Harold Weise, manufacturer's agent, St. Louis, Mo.

Directors: W. E. Illig, Banner Iron Works, St. Louis; Charles Rothweiler, Hickman Williams Co., St. Louis; L. H. Horneyer, manufacturer's agent, St. Louis; and John Holtman, American Manganese Steel Div., St. Louis.

Report of the nominating committee was presented by its chairman, Chapter Director L. A. Kleber, General Steel Castings Corp., Granite City, Ill.; and those placed in nomination were elected by acclamation.

Also presented was the annual financial report, which was read and submitted to the audit committee. Walter Zeis, Midwest Foundry Supply Co., Edwardsville, Ill., chairman of the membership committee, reported paid up membership of 235, an increase over the 228 of last year.

Technical session of the evening featured a discussion of "History and Development of the Foundry Industry," presented by Bruce Simpson, National Engineering Co., Chi-

1945-46 Saginaw Valley Chapter officers and directors.

Special March meeting of the Northwestern Pennsylvania chapter at Penn Grove Hotel, Grove City, Pa., drew an attendance of more than ninety-five, pictured here in the ballroom, for the dinner and technical session.

cago. Mr. Simpson, nominee for A.F.A. National Director, held the attention of the foundrymen present with the fascinating story of casting of metals, traced from earliest records to the year 1896, with comparison of practices and progress made in different countries.

Central Indiana

B. P. Mulcahy
Citizens Gas & Coke Utility
Chapter Director

ANNUAL DOUBLE-HEADER meeting of the Central Indiana A.F.A. chapter, with the membership dividing into two groups, ferrous and nonferrous, was held April 1 at the Athenaeum, Indianapolis, with A. S. Klopf, Lester B. Knight & Associates, Chicago, discussing "Casting Defects in Gray Iron," and A. K. Higgins, Allis Chalmers Mfg. Co., Milwaukee, considering "The Correlation of Metallurgical and Foundry Properties of Non-Ferrous Alloys."

Mr. Klopf, member of the A.F.A. Committee on Analysis of Casting Defects, reviewed the principal flaws found in gray iron castings; and pointed out that defects must first be classified, next traced to their source in the foundry, and, finally, eliminated through corrective procedures. The speaker used slides to illustrate aspects of the subject matter under consideration. Serving as technical chairman for the session was R. C. Robertson, International Harvester Co., Indianapolis.

With Fred Carl, Delco-Remy Div., General Motors Corp., Anderson, Ind., presiding as technical chairman of the non-ferrous group, Mr. Higgins, Chairman, Subcommittee on Aluminum Bronze, A.F.A. Brass and Bronze Division, presented a comprehensive discussion of his topic.

Philadelphia

E. C. Troy
Dodge Steel Co.
Chapter Director

SPECIFIC TYPES of casting defects and their remedies were described before an unusually heavy attendance at the April 12 meeting of the

CHAPTER MEETINGS—MAY-JUNE

May 23

Northeastern Ohio
Cleveland Club
ELECTION AND OLD TIMERS NIGHT

Canton District
Mergus Restaurant, Canton
ZIGMOND MADACEY
Caterpillar Tractor Co.
"Core Blowing"
NATIONAL OFFICERS PROGRAM

May 24

Southern California
Roger Young Auditorium, Los Angeles
PROFESSOR E. R. MERTZ
University of Southern California
"Blueprint Reading"

Chicago
Chicago Bar Association
MAX KUNIANSKY
Lynchburg Foundry Co.
"Castings in Post-War Industry"

Chesapeake
Engineers Club, Baltimore, Md.
H. J. WILLIAMS
New Jersey Silica Sand Co.
"Mining and Processing of Foundry Sands"

Philadelphia
Engineers Club
"Engineering & Pattern Design"

May 25

Southern California
Lakewood Country Club
LADIES NIGHT

Western New York
Buffalo Trap & Field Club
Buffalo, N. Y.
ANNUAL DINNER DANCE

May 27

Northwestern Pennsylvania
Moose Club, Erie
B. L. SIMPSON
National Engineering Co.
"History of the Foundry Industry"

Central Ohio
Chittenden Hotel, Columbus
ROUND TABLE MEETING

June 8

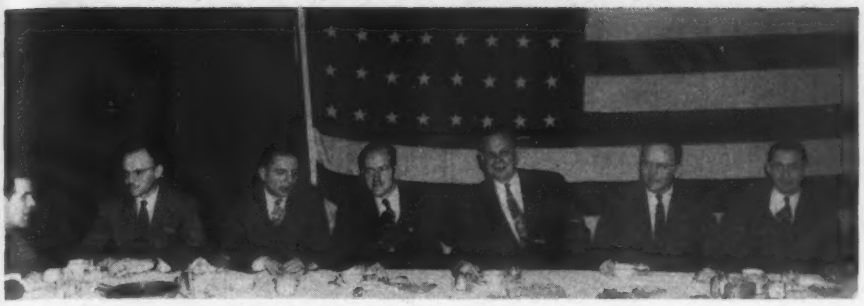
Central Illinois
Shore Acres Country Club
Chillicothe, Ill.
PICNIC

June 13

Texas
Houston
CHAPTER ELECTION

June 15

Western New York
Kudara Farms, Hamburg, N. Y.
ANNUAL MEETING AND PICNIC



View of the speaker's table at the annual double-header meeting of Central Indiana chapter, held April 1 at the Athenaeum, Indianapolis.

Philadelphia chapter, in the Engineers Club, by Clyde L. Frear, U. S. Navy, Washington, D. C., member of the A.F.A. Inspection of Castings Committee.

Mr. Frear limited his broad topic, "Casting Defects and Their Remedies," by presenting with his opening remarks radiographs of the particular flaws under consideration. Acting as technical chairman for the session was Fred G. Sefing, International Nickel Co., N. Y., who is active in the Executive Committee and the Subcommittee on Engineering Properties Symposium, A.F.A. Gray Iron Division.

Rochester

D. E. Webster
American Laundry Machinery Co.
Chairman, Publicity Committee

GUEST SPEAKER at the April 9 meeting of the Rochester A.F.A. chapter, in the Hotel Seneca, Rochester, N. Y., was a member of the Western New York chapter, T. L. Nelson, National Carbon Co., N. Y., who discussed applications of carbon in the foundry.

Pointing out the trend in recent years toward larger electrodes and greater varieties of shapes, the speaker emphasized that production of these products requires utmost skill and attention to detail in manufacture, machining, treatment and shipment.

Saginaw Valley

J. J. Clark
Saginaw Malleable Iron Div.
General Motors Corp.
Chapter Reporter

GATHERING at the Fischer Hotel, Frankenmuth, Mich., April 4, for its regular monthly dinner meeting, the Saginaw Valley A.F.A. chapter heard Dr. C. R. Austin, Meehanite Metal Co., Cleveland, describe and analyze "Heat Treatment of Iron Castings."

The speaker devoted the first portion of his talk to treatment and test methods used in sub-critical heating for stress relieving. Slides were used to demonstrate the effect of time and temperature.

Dr. Austin's following remarks were devoted to methods for improvement of properties of cast iron through heat treatment at temperatures above the critical range. Comparisons were made of characteristics of the metal as cast, after conventional quench and draw, and after austempering.

Western New York

L. A. Merryman
Tonawanda Iron Corp.
Chapter Secretary

HISTORY AND DEVELOPMENT of a ferrous material characterized by unique physical properties were related to the Western New York A.F.A. chapter meeting, April 5, at the Hotel Touraine, Buffalo, N. Y., by J. H. Lansing, Malleable Iron Founders' Society, Cleveland, whose topic was "Malleable Iron."

Mr. Lansing, a member of the Executive Committee and Chairman of the Committee on Round Table Conference, A.F.A. Malleable Division, described applications of malleable iron during the war; in tanks, gun mounts, and bomb and ammunition components. Peacetime role of the material in the automotive, railroad, agricultural and electrical fields also was outlined.

Chicago

E. F. Ross
The Foundry
Chapter Reporter

ROUND TABLE MEETINGS continued to command top interest of Chicago A.F.A. chapter members, with attendance close to 200 for the last in a series of three, April 1, at the Chicago Bar Association, as Chapter Chairman J. C. Gore, Werner G. Smith Co., Chicago, presided over general portions of the meeting, and Chapter Vice-Chairman L. H. Hahn, Sivyer Steel Casting Co., of the same city, over round table sessions.

Gray Iron round table, under chairmanship of G. W. Merrefield,

Some views of the April 4 meeting of the Saginaw Valley chapter. Below (left to right), Chapter Chairman J. F. Smith, Chevrolet Grey Iron Foundry, Saginaw, Mich.; W. G. Mixer, Buick Div., General Motors Corp., Flint, Mich.; Dr. C. R. Austin (speaker of the evening), Meehanite Metal Co., Cleveland; and Chapter Secretary-Treasurer M. V. Chamberlin, Dow Chemical Co., Midland, Mich., take time out for an informal chat.

Scenes at the University of Pennsylvania, Philadelphia, during the recently concluded lecture course on fundamentals of foundry practice, sponsored by the Philadelphia A.F.A. chapter.

Chicago Hardware Foundry Co., North Chicago, Ill., heard a discussion of "Gray Iron Sand Service" by G. W. Anselman, Geobig Mineral Supply Co., Chicago. The speaker, who is active in the A.F.A. Foundry Sand Research Project, dealt with natural bonded and synthetic sands and influence of grain size distribution.

Attention of the Malleable session was focused on control of composition and insurance of uniform response to annealing by M. E. McKinney, International Harvester Co., Chicago, who discussed "Melting Furnace Atmosphere Control." Cecil Semrau, Illinois Malleable Iron Co., Chicago, presided.

Topic of the Non-Ferrous group was "Certain Aluminum Foundry Problems—Their Causes and Elimination," by R. G. Quadt, Federated Metals Div., American Smelting & Refining Co., Perth Amboy, N. J. Acting as presiding officer was a member of the Executive Committee, A.F.A. Aluminum and Magnesium Division, Oscar Blohm, Hills-McCanna Co., Chicago.

Before the Steel session, another active participant in A.F.A. Foundry Sand Research Project, J. A. Rassenfoss, American Steel Foundries, East Chicago, Ind., Vice-Chairman of the Properties of Steel Foundry Sands subcommittee, discussed "Sand Control." Presiding as chairman was W. A. Linchester, Western Foundry Co., Chicago; while L. F. Dennie, Burnside Steel Foundry Co., Chicago, acted as discussion leader.

During the general business meeting, report of the chapter nominating committee was presented by its chairman, James Thomson, Continental Foundry & Machine Co., East Chicago. Announcement was made of postponement of the May meeting, at which elections will be held, to later in the month to avoid conflict in dates with the National Convention.

Central Ohio

Tom Barlow
Battelle Memorial Institute
Chapter Chairman

INTERESTED DISCUSSION by the members followed presentation of the topic, "Core and Mold Coatings for Iron and Steel," by Dr. J. A. Ridderhof, Frederic B. Stevens, Inc., Detroit, before the March 25 meeting of Central Ohio chapter at the Chittenden Hotel, Columbus.

Effect of individual ingredients in various washes now on the market were described by the speaker, who also illustrated the specific use of each. Recommendations as to precautions necessary for obtaining optimum results in the foundry, as well as techniques for storing, mixing, transporting and using washes, were presented by Dr. Ridderhof. Details of various means of application, and instances in which each method proved superior were cited.

In the discussion period, questions raised concerned such aspects as use of double coatings, either sprayed or brushed, and methods of increasing or decreasing resistance to penetration of certain coatings.

Birmingham District

J. P. McClendon
Stockham Pipe Fittings Co.
Chairman, Publicity Committee

PANEL DISCUSSION of "Mechanization in the Foundry," conducted by E. H. King, Hill & Griffith Co., Cincinnati, and J. S. Schumacher of the same firm, Vice-Chairman of the Cincinnati A.F.A. chapter, explored aspects of modernization before more than 100 members and guests at the March 22 meeting of the Birmingham District A.F.A. chapter in the Tutwiler Hotel, Birmingham; with Chapter Chairman J. A. Woody, American Cast Iron Pipe Co., Birmingham, presiding over the meeting, and Program Chairman J. A. Bowers of that company taking the chair for the question and answer session.

Aggressive competition from other fields was cited by the speakers as a factor weighing heavily in favor of mechanization in the foundry; which was said to permit the small shop to expand its market potentials. Mr. King stressed the feasibility of un-

Speaker of the evening, H. C. Winte (center), Worthington Pump & Machinery Co., Buffalo, N. Y., discusses one of the exhibits presented in his discussion of gates and risers at the March meeting of the Central New York chapter with Chapter Vice-Chairman E. E. Hook (left), Dayton Oil Co., Syracuse, N. Y., and National Director H. H. Judson, Goulds Pumps, Inc., Seneca Falls, N. Y.

Members and guests of the Central New York chapter at the March 8 dinner meeting.

dertaking a mechanization program progressively, in steps, so that costs may be paid out of increased profits resulting from more efficient procedures.

Various phases of sand handling were discussed in detail; screening, sand cutting, sand preparation, core oven design and casting shakeout being considered. Numerous modern plant layouts were noted. Importance of removal of fines was emphasized. The speakers, while ceding the point that mechanization does decrease flexibility somewhat, stated that optimum requirements of a shop may be engineered through proper planning.

Metropolitan

C. J. Law
Worthington Pump & Machinery Corp.
Chapter Director

TURNING OUT to hear J. A. Gitzen, Delta Oil Products Co., Milwaukee, discuss "Core and Mold Washes," 150 members of the Metropolitan A.F.A. chapter attended the April 1 meeting, at the Essex House, Newark, N. J.; Chapter Vice-Chairman H. L. Ullrich, Sacks Barlow Foundries, Inc., Newark, presiding, and W. G. Reichert, Reichert Engineering Co., of the same city, acting as technical chairman.

Mr. Gitzen, recognized authority on his subject, who serves as Chairman, Subcommittee on Core Washes, A.F.A. Foundry Sand Research Project, detailed desirable properties of a good wash, which should: (a) mix easily, stay in suspension and not ferment or decompose; (b) wet sand surface readily and penetrate 3 to 5 grains; (c) be waterproof; (d) have zero permeability with application of one coat (at present two coats are usually considered necessary); (e) maintain a tough, refractory surface at elevated temperatures; (f) resist cracking from heat of molten metal; (g) allow metal to lie smoothly in mold surfaces—hence, must not be too hard nor generate any appreciable amount of gas; and finally, (h) not react with molten metal, in the case of steel, not contain an appreciable amount of carbon.

Further recommendations presented by the speaker concerned proper handling of wash materials, use of additions, maintenance of sand consistency, selection of sands and application of washes.

An informative general discussion followed Mr. Gitzen's remarks. Among points raised was the question of determining when cores are fully baked; and general agreement was expressed that it still seems necessary to break a representative piece and check hardness while sand is hot, no instrument being available for determination by other means.

Northwestern Pennsylvania

E. M. Strick
Erie Malleable Iron Co.
Chapter Vice-Chairman

TWO SUCCESSFUL MEETINGS featured the March activities of the Northwestern Pennsylvania chapter: a special session, March 20, at the Penn Grove Hotel, Grove City, Pa., attended by 95 members and guests; and the regular meeting, March 25, at the Moose Club, Erie, with 125 in attendance.

Topic of the evening at Grove City was "The Metallurgy of Gray Iron," presented by T. E. Eagan, Cooper-Bessemer Corp., of that city. Mr. Eagan, Chairman, A.F.A. Gray Iron Division, emphasized the importance of inoculation in regard to graphite flakes which affect tensile strength of gray iron; and illustrated this aspect of his subject with slides.

Technical chairman for the occasion was George Johnstone, Cooper-Bessemer Corp. Dr. Craig S. Hoyt, science faculty, Grove City College, spoke briefly and praised the strides the foundry industry is making in the education of young men through the A.F.A. Technical Development Program. Chapter Director T. H. Beaulac, Chicago Pneumatic Tool Co., Franklin, Pa., expressed the thanks of the chapter to those present for their cooperation in making such special meetings successful and valuable during the season when weather conditions prevent travel to Erie.

The regular meeting at Erie, with Chapter Chairman R. W. Griswold, Jr., Griswold Mfg. Co., Erie, presiding, heard Ralph L. Lee, Employee Relations Staff, General Motors Corp., Detroit, discuss "Humanics in the Foundry." Foundrymen displayed keen interest in the discussion of human relationship, presented in foundry language.

Also present, and introduced to the audience, were ten representatives of the Foremen's Association of Erie, who are cooperating in the foundry exhibit to be presented at the local Y.M.C.A. the week of June 5. A. L. Mould, local Y.M.C.A. secretary, offered the facilities of his organization to the chapter and the Foremen's Association; and Chapter Director D. J. James, Erie City Iron Works, Erie, general chairman for the exhibit, gave a brief sketch of plans for this outstanding chapter educational activity.

Chapter Director L. A. Dunn General Electric Co., Erie, chairman of the chapter educational committee, reported on completion of plans

for installation of equipment in the new foundry school, to be opened in September at the local Academy High School.

Central Illinois

C. W. Wade
Caterpillar Tractor Co.
Chapter Secretary

MODERN FOUNDRY is "one in which the engineering is done before the job gets to the molding floor," L. B. Knight, Lester B. Knight & Associates, Chicago, observed in his discussion of "Foundry Mechanization and Modernization" before the Central Illinois A.F.A. chapter, meeting March 18 at the Jefferson Hotel, Peoria, Ill., with Chapter Chairman L. E. Roby, Peoria Malleable Castings Co., Peoria, acting as presiding officer.

The speaker stated that foundry modernization involves modern thinking on the part of owners, engineers and operators, as well as the installation of improved facilities. Remarking that equipment is no better than the men behind it, Mr. Knight declared it essential that the foundry be properly organized, with authority designated so that one individual makes decisions on matters of policy or practice. A staff of specialist assistants around the man in authority is often a means of preventing many foundry troubles, the speaker pointed out.

Thorough analysis of methods and costs of departments in the plan was recommended as first step toward modernization; to be followed by detailed outline of requirements and costs, illustrating economies of proposed changes. Major improvements should be self-amortizing within a short period of time, Mr. Knight stated, commenting that, generally, such changes properly undertaken are paid for through economies in from 12 to 30 months.

(Photos courtesy Paul Pufahl & Son Foundry, Minneapolis.)

Some of seventy-seven members and guests who took part in discussion of lubrication and maintenance problems, and enjoyed the dinner, at the Twin City chapter's March meeting.

Connecticut Non-Ferrous

L. G. Tarantino
Niagara Falls Smelting & Refining Corp.
Association Secretary

TECHNICAL SUBJECT of the evening at the Connecticut Non-Ferrous Foundrymen's Association meeting, March 20, in the Hotel Taft, New Haven, Conn., was the history of copper and bronze, presented in a motion picture, "Golden Horizons."

Made available through courtesy of Ampco Metal, Inc., Milwaukee, the color film, which concerns the metals from Stone Age to present, proved interesting and instructive to those in attendance.

Speaker of the evening at the March special meeting of the Northwestern Pennsylvania chapter at Penn Grove Hotel, Grove City, Pa., was T. E. Eagan (second from left), Cooper-Bessemer Corp., Grove City, Chairman, A.F.A. Gray Iron Division, who is shown here with: (left) Chapter Vice-Chairman E. M. Strick, Erie Malleable Iron Co., Erie, Pa.; Dr. C. S. Hoyt, Grove City College; and Chapter Secretary H. L. Gebhardt, United Oil Mfg. Co., Erie.

Twin City

P. R. Hesse
Union Brass & Metal Mfg. Co.
Chapter Reporter

REGULAR MEETING of the Twin City A.F.A. chapter was held March 19 at the Curtis Hotel, Minneapolis, with Chapter Chairman R. C. Wood, Minneapolis Electric Steel Castings Co., of that city, presiding and Frank Ross, national manager, Lubrication Department, E. F. Houghton Co., Philadelphia, as speaker of the evening on "Lubrication and Maintenance Problems in a Foundry."

The speaker, whose background includes experience in research work and development and field testing of lubricating oils and greases, particularly additive-containing lubricants, discussed methods and importance of oiling and greasing foundry equipment. Charts and slide were presented to illustrate effect of exposure of various types of bearing to contamination.

Among those at the speaker's table were A. A. Gustafson and E. F. Gustafson, both of A. A. Gustafson

(Continued on Page 102)

ABSTRACTS

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th St., New York, N. Y.

Aluminum-Base Alloys

DENSITY. Daugherty, M. W., and Kempf, L. W., *"Density of Light Alloy Castings,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 38-43.

The authors discuss the possible errors involved in the use of density determination for measuring the soundness of castings. They suggest some methods for reducing these errors to a minimum and illustrate the application of the methods. They make some observations on the practical significance of variation in the density of castings.

Brass and Bronze

CENTRIFUGAL CASTING. Northcott, L., and Lee, O. R. J., *"The Centrifugal Casting of Aluminum Alloy Wheels in Sand Moulds,"* Reprint from JOURNAL OF THE INSTITUTE OF METALS, 1945, vol. 71, Part 3, pp. 93-130.

Wheels have been centrifugally cast in sand moulds rotated on a vertical axis, using four aluminum-rich alloys: DTD 304, 2L33, DTD 300, and RR 50. In centrifugal castings of spoked wheels, porosity tends to be concentrated at the junctions of the arms with the rim and cannot be eliminated by increasing the speed of rotation unless the cross-sections of the arms are larger than in normal practice for static castings. A working rule of 1 in. cross-section of arm for each 10 in. of metal in the rim has been found to represent the minimum proportions required. Of the alloys investigated, 2L33 suffers least and DTD 300 most if the arms are of inadequate size. In general, the highest practicable speeds of rotation are desirable for light alloy castings, since the internal centrifugal pressure is naturally low for metal of low density. For the wheel patterns employed, a minimum peripheral speed of 2600 ft./min. was desirable, producing a pressure of 32 lb./in. on the mould wall.

The mechanical properties of samples from three positions in each casting were determined. Although there was only a slight increase in density, test-bars from centrifugal castings in DTD 304 showed an improvement of 15 per cent in tensile strength and 78 per cent in elongation over a static casting. For DTD 300, the corresponding increases were 20 to 60 per cent, respectively. Only slight improvements in mechanical properties were obtained with RR 50 and 2L33. In the latter alloy, centrifugal casting had the effect of coarsening the eutectic structure with the particular modification technique employed. When the complete wheels were tested to destruction, the centrifugally cast wheels withstood a maximum load on the average 16 per cent higher than the statically cast wheels.

The macrostructure of the centrifugal castings showed columnar crystals growing from inner vertical surfaces, with equi-axial crystals in the outer zones of the castings. As the speed of rotation increased, the columnar crystals became longer and the equi-axial crystals smaller. Additional castings in other selected alloys provided data which confirmed an explanation of the origin of the structures based on the operation of a centrifuging action during the solidification interval, when the densities of liquid and solid are different.

POROSITY. Colton, Lt. Robert A., *"Gases in Bronze,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 88-89, 134, 136, 141.

A digest of previous literature on gas porosity in copper-base alloys.

A bibliography of 58 references is appended.

Cores

COREBLOWING. Pridmore, Lawrence D., *"Core Blowing Practice,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 94-95, 168, 171.

The most important factor in core blowing practice is venting technique. Types of sand and pressures are also important.

The author answers a number of questions asked by foundrymen about core blowing.

Costs

NON-FERROUS. *"Non-Ferrous Cost Accounting,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 100-102, 154, 156, 158.

The second installment of the "Simplified Accounting Procedure and Cost Methods," prepared by the Non-Ferrous Founders' Society. This installment describes how to determine costs.

Cupola Practice

CHARGING EQUIPMENT. Gregg, A. W., *"What Type Charger and Charging Bucket,"* THE FOUNDRY, December, 1945, vol. 73, no. 12, pp. 84-87, 228, 230, 232.

What type of charging equipment should be used depends upon the quality of product to be cast; the size of the cupola; the maximum and minimum tonnage per hour and per day to be handled in the cupola; the number of hours the cupola is in operation; size of the metal charge; coke ratio; density of the metallic charge; and the size of scrap used.

Design

PATTERN REDESIGN. (See *Patterns.*)

Design of Castings

PRINCIPLES. Shestopal, Victor M., *"The Technological Principles of Casting Design,"* FOUNDRY TRADE JOURNAL, December 13, 1945, vol. 77, no. 1530, pp. 317-322; December 20, 1945, vol. 77, no. 1531, pp. 339-346.

The author, who is a professor of the Stalin Machine Tool Institute of Moscow, emphasizes simplicity as the keynote to good casting design. Design features should provide for ease in molding, progressive solidification, uniform section thicknesses, easy removal of gates and risers, and utilization of the inherent good properties of the casting metal. The author describes in detail how these things may be achieved.

Included in the articles are specifications found in the U.S.S.R. Standards for castings.

The article concludes with an analysis of the design requirements of a machine-tool bed casting and an engine base.

Die Casting

PRODUCTION AND USES. Chase, Herbert, *"Die Casting,"* MATERIALS AND METHODS, November, 1945, vol. 22, no. 5, pp. 1441-1452.

Methods of production; types of alloys used; advantages and limitations; design principles; present and future applications.

Furnaces

CHARGING EQUIPMENT. (See *Cupola Practice.*)

Gray Cast Iron

FLUOROSCOPIC. Cassen, B., and Clark, D. S., *"Fluoroscopy,"* METAL INDUSTRY, December 7, 1945, vol. 67, no. 23, pp. 375-377; see also THE IRON AGE, November 1, 1945, vol. 156, no. 18, pp. 54-59.

In carrying out an investigation of fluoroscopy with light alloy castings, the authors draw comparisons with this method of flaw detection in castings and that by means of radiography. The method by which they undertook this investigation is given together with some results of their experiments.

FLUOROSCOPY. (See *Inspection.*)

HARDNESS TESTS. Hindley, W. N., *"Sources of Error in Diamond Pyramid Hardness Measurements on Hardened Steel,"* Advance Copy, THE IRON AND STEEL INSTITUTE, September, 1945, 10 pp.

The purpose of this work was to determine the extent to which the results of diamond pyramid hardness (H_D) tests carried out by independent observers on hardened steel could be relied upon, experience having shown that some observers reported widely different results on material of the same nominal composition and heat-treatment. The conclusions apply generally to all hardness testing. As materials or compositions are sometimes accepted only to a given H_D specification, it is important that the H_D figures obtained should be reliable. Wide variation in the results reported by independent observers was found, although results within close limits of agreement were obtained on the same samples by an experienced observer, when care was taken in the preparation of the flats. The wide variations obtained are attributed

to carelessly prepared flats, and a standardized procedure for surface preparation is therefore recommended.

METHODS. Hart, R. J., *"Notes on Inspection,"* FOUNDRY TRADE JOURNAL, January 3, 1946, vol. 78, no. 1533, pp. 3-8, 21.

An outline of the objects and methods of inspection of castings and pattern equipment in use in a steel foundry.

PROCEDURE. Hammond, A. F., *"Compressor Castings,"* FOUNDRY TRADE JOURNAL, December 20, 1945, vol. 77, no. 1531, pp. 351-352.

A description of the inspection procedure followed in a foundry producing air compressor castings.

RESIDUAL ELEMENTS AND GASES. Hurst, J. E., *"Residual Elements and Gas Contents of Cast Iron,"* FOUNDRY TRADE JOURNAL, December 27, 1945, vol. 77, no. 1532, pp. 363-369.

A discussion of the extent of structural changes which may result from minute variations in the content of trace elements and gases.

SURFACE CHARACTERISTICS. Somers, Edward V., *"Preventing Gray Iron Surface Roughness,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 84-87, 171.

Most of the corrective methods applied to reduce metal penetration depend upon the ferrostatic head for their effectiveness. Successful methods include reduction of ferrostatic head on the casting; increased mold hardness with ferrostatic head under 20 in.; blacking and skin drying the mold with ferrostatic heads over 20 in.; and for thin-sectioned castings with low ferrostatic heads pouring at a lower temperature.

Inspection

NON-DESTRUCTIVE. *"Non-Destructive Testing of Steel Castings,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 35-36.

Methods, development, and progress in setting up standards for non-destructive testing are reported to members of A.F.A. Steel Division. A bibliography of recent publications contains articles on non-destructive testing of steel castings, technique and fundamentals related to radiography of steel castings.

Magnesium-Base Alloys

MAGNESIUM-CERIUM. Marande, R. F., *"Magnesium-Cerium Alloy Castings for High Temperature Use,"* MATERIALS AND METHODS, February, 1946, vol. 23, no. 2, pp. 418-424.

A detailed discussion of melting and casting methods that have been found necessary in handling magnesium-cerium alloys in the foundry.

Fluxing, alloying, pouring, and gating and risering are the main topics.

Successful foundry practice involves the use of $MgCl_2$ flux for all holding and remelting operations in order to keep cerium loss at a minimum, pouring the melt immediately after alloying, keeping holding and pouring temperatures at a minimum, and using a gating and riser method illustrated in the article.

Since magnesium-cerium alloys have better high-temperature properties than have other magnesium-base alloys, their use is indicated for aircraft engine parts.

SUPERHEATING. Tiner, N., *"Superheating of Magnesium Alloys,"* METALS TECHNOLOGY, October, 1945, vol. 12, no. 7, 19 pp.

Mechanical properties of magnesium-base alloys are improved by grain refinement. Proper melting and superheating techniques can affect this refinement.

The author gives the following results of experiments in which thermal conditions of melting were varied while other factors capable of influencing grain refinement were held constant:

"1. The grain refinement of magnesium alloys by superheating is maximum at a certain temperature range between 850° and 900° C., and at higher temperatures of superheating there is a tendency for grain coarsening.

"2. Superheating molten alloys for several hours at low temperatures produces some grain refinement, but as the superheating temperature is raised to about 850° C., the time required to get the full effect drops off to zero.

"3. (a) The superheating effect on grain size is gradually and completely neutralized by holding the molten alloys for increasing periods of time at low temperatures before casting.

"(b) When the molten alloys are held at a given temperature for a sufficient length of time, the resultant grains exhibit, within certain limits, the same size whether the melts are brought to the desired temperature from lower or from higher temperatures.

"4. Stirring the molten alloys at about 800° C. causes a considerable grain refinement, but when stirring is carried out at 700° C. the resultant solid generally has coarser grains.

"5. All other factors being practically constant, the grain size of an alloy varies, within certain limits, with the structure of the charge before melting; this variation in grain size is noticeable when the melts are superheated at low temperatures for short periods of time, but decreases and completely disappears as the superheating temperature is increased.

"6. Repeating superheating of the melts at elevated temperatures (850° to 900° C.) does not produce any appreciable change in grain size of resultant castings.

"7. The superheating effect on grain size can be suppressed neither by carrying out the melting operations in vacuum, nor by treatment with a powerful deoxidizing agent, such as lithium or potassium.

"8. Bubbling nitrogen, chlorine and helium through superheated alloys has no appreciable effect on grain size, whereas bubbling hydrogen produces a relatively fine-grained structure with numerous blow-holes."

Malleable Cast Iron

INCREASING PRODUCTION. Dwyer, Pat, *"Increases Malleable Iron Capacity,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 90-93.

A description of how a malleable foundry revamped and reequipped the existing plant, introduced new methods of operation, and increased the working force to permit 24-hour operation in order to increase production.

Molding Sands

HOT STRENGTH. Davies, W., and Rees, W. J., *"The Hot-Strength Characteristics of Moulding Sands,"* Advance Copy, THE IRON AND STEEL INSTITUTE, December, 1945, 10 pp.

This paper summarizes the results so far obtained in the research on the hot-strength characteristics of moulding sands which is in progress at Sheffield University. A description of the apparatus employed is given. Attention has so far been directed towards the differences between the hot-strength characteristics of the various clay bonds in relation to their mineralogical constitution. All the bonds so examined show a gradual increase in strength with rise of temperature. After a maximum strength is reached, the strength decreases rapidly. This peak hot strength is attained at a temperature of 900-1000° C. for clays having the silica-gibbsite-silica structure, e.g., montmorillonite or secondary mica, and at a temperature of more than 1150° C. for clays having the silica-gibbsite, i.e., kaolinite, structure.

Patterns

PLASTIC. (See *Precision Casting.*)

REDESIGN. Moorhead, Ernest C., *"Pattern Redesign for Increased Production,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 26-28.

Pattern equipment may frequently be redesigned to give more efficient production and lower costs per casting. The time required for such adaptation may be well worth while.

Precision Castings

BRASS AND BRONZE. Lipson, S., Markus, H., and Rosenthal, H., *"Precision-Cast Copper-Base Alloys,"* THE IRON AGE, November 8, 1945, vol. 156, no. 19, pp. 44-73.

Experimental data on precision-cast leaded red brass, leaded yellow brass, manganese bronze and silicon brass are presented. The effects of such factors as flask temperatures and prequench time intervals on the physical properties and microstructures are discussed.

PLASTIC PATTERNS. Post, Charles T., *"Precision Casting With Plastic Patterns,"* THE IRON AGE, November 15, 1945, vol. 156, no. 20, pp. 54-59.

The use of injection molded polystrene patterns overcomes the problem of perishability found with wax patterns while affording high dimensional accuracy, smooth finish and reproductibility on long runs.

VACUUM CASTING. Dittmar, Francis, *"Precision Founding,"* THE IRON AGE, November 22, 1945, vol. 156, no. 21, pp. 68-71.

The author describes a setup whereby a vacuum is applied while the metal is being poured to secure elimination of gases, and how the vacuum method can be joined to centrifugal casting to procure a dense, sound metal.

Radiography

INSPECTION. (See *Inspection.*)

INTENSITY DISTRIBUTION. Russ, George A., *"Intensity Distribution of X-ray Units—150 K.V. and 250 K.V.,"* INDUSTRIAL RADIOGRAPHY, Fall Number, 1945, vol. 4, no. 2, pp. 22-23.

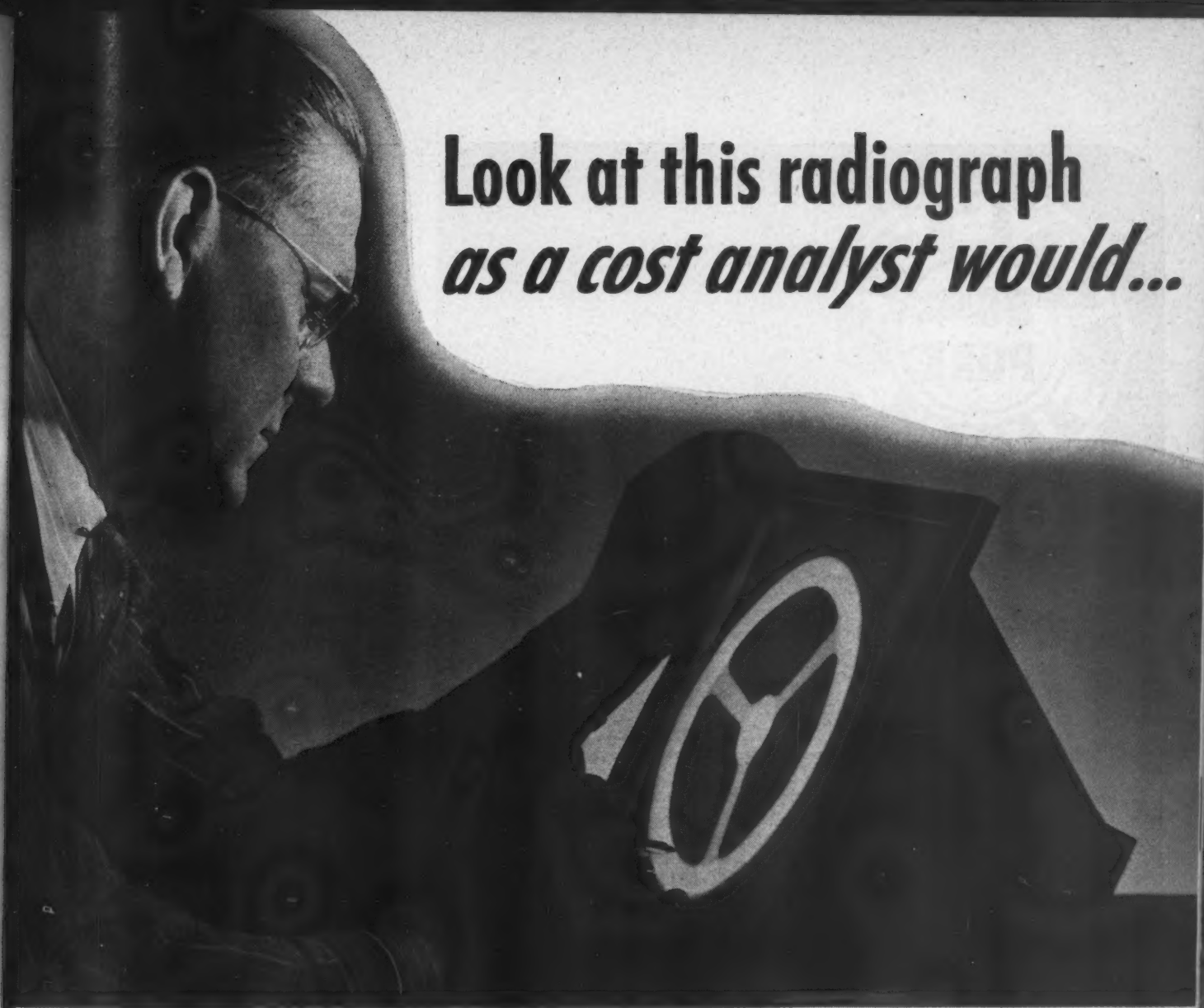
The paper investigates the intensity distribution of the two most widely used x-ray units. A knowledge of this distribution will enable the radiographer to utilize the x-ray beam to his best advantage and arrange the set-up of his objects accordingly.

INTERPRETATION. Clauser, Henry R., *"Accurate Interpretation of Radiographs,"* MATERIALS AND METHODS, November, 1945, vol. 22, no. 5, pp. 1418-1422.

A discussion of factors which influence the accuracy of radiograph interpretation, such as sensitivity, contrast and definition, film blemishes, and viewing facilities.

PRODUCTION TECHNIQUES. Solow, Henry A., *"Precision Mass Production Technique in Industrial Radiography,"*

(Continued on Page 98)



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Abstracts

(Continued from Page 94)

INDUSTRIAL RADIOGRAPHY, Fall Number, 1945, vol. 4, no. 2, pp. 31-34.

A discussion of the benefits in precision, speed, and economy, which result from the use of a patented method for speedy mass production of industrial radiographs.

PROTECTION. *"Protection Against X-rays and Gamma Rays,"* INDUSTRIAL RADIOGRAPHY, Fall Number, 1945, vol. 4, no. 2, pp. 35-43.

The tolerance dose or tolerance intensity; radiation injury; genetic injury; human factors; x-ray protection in industrial fluoroscopy; and materials and methods of x-ray protection.

PURCHASE STANDARDS. Ball, Leslie W., *"X-ray Standards for Purchasing Castings,"* THE IRON AGE, November 22, 1945, vol. 156, no. 21, pp. 62-64.

Any radiographic standard for the purchasing of castings should be guided by the criticalness of the section in determining what type of defect is or is not acceptable.

QUALITY CONTROL. Cata, Alvin F., *"Control of Radiographic Quality Through Direct Density Checks,"* INDUSTRIAL RADIOGRAPHY, Fall Number, 1945, vol. 4, no. 2, pp. 11-17.

Constant density and contrast are of the utmost importance to the interpretation of radiographs. Density may be controlled by determining the most suitable density range, plotting a control chart, and making the necessary additions to the processing solutions to correct for density changes.

QUALITY CONTROL. Mullowney, George, *"X-Ray As a Foundry Control Tool,"* ALUMINUM AND MAGNESIUM, February, 1946, vol. 2, no. 5, pp. 18-21.

An argument in favor of the use of x-ray as a means of controlling casting defects.

UTILITY. Caldwell, Thomas E., *"Radiography from the Metallurgical and Inspection Standpoint,"* INDUSTRIAL RADIOGRAPHY, Fall Number, 1945, vol. 4, no. 2, pp. 28-30.

A discussion of the way in which both the producer and consumer can utilize radiography to his best advantage.

Refractories

APPLICATION. *"The Role of Refractories in Peacetime Production,"* BRICK AND CLAY, January, 1946, vol. 108, no. 1, pp. 67-76.

An appraisal based primarily on refractory use and performance in wartime production, in order to determine and evaluate future applications of refractories.

Types of refractories covered include acid proof, castable, mullite, high alumina, zircon, carbon, fireclay, sillimanite, silicon carbide, insulating brick, magnesite, chrome, chrome-magnesite, ramming mixes, plastic fire brick, forsterite, and silica refractories.

NITROGEN. Redmond, John C., Gerst, Leona, and Touhey, W. O., *"Determination of Nitrogen in Refractory Metal Carbides and Their Compositions,"* INDUSTRIAL AND ENGINEERING CHEMISTRY, Analytical Edition, January, 1946, vol. 18, no. 1, p. 24.

A valuable addition to the meager literature on determination of nitrogen

in carbides, the method described involves solution of a finely ground sample in a strong acid-oxidizing solvent. Distilling from a strong sodium hydroxide solution in a simple apparatus made of standard laboratory glassware, ammonia which is formed collects in a solution of standard sulfuric acid. Titrating the excess sulfuric acid with standard sodium hydroxide indicates the amount of nitrogen present in the original sample. Although solution of the sample requires a long time the method gives precise results.

Safety and Hygiene

DUST CONTROL. Kane, John M., *"Foundry Ventilation,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 104-108, 144, 146, 150.

A discussion of ventilation requirements of sand systems, molding floor, and cleaning room.

Salvage

STEEL CASTINGS. Cotton, J. F., *"Steel Castings Repair Methods,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 29-34.

Defects may be removed from steel castings by one of three methods—chipping, grinding, or flame gouging. Which method should be used depends upon the casting service, character of the defect, and metal composition. After removal of the defect, it is necessary to decide whether it should be filled in and by what means.

Sand

CONTROL. Clark, Joseph J., *"Malleable Sand Control in a Large Mechanized Foundry,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 49-56.

A description of the raw materials, equipment and controls employed in the synthetic, all-facing sand systems of a modern, high production malleable iron foundry, producing medium finish automotive and gun part castings, the weights ranging from a few ounces to 65 lb.

HEAT TRANSFER. Schwartz, H. A., *"The Influence of Radiation Within Molding Sand on the Freezing Rate of Metal,"* AMERICAN FOUNDRYMAN, vol. 8, no. 11, pp. 45-48.

The relation of amount of metal frozen to time cannot be satisfactorily explained if the conductivity of molding sand is taken as independent of temperature. A better correlation can be obtained if the heat transfer within the sand is assumed to take place in part by conduction and in part by radiation.

METAL PENETRATION. (See *Gray Cast Iron, Surface Characteristics.)*

Steel

CONVERTER. Hall, John Howe, *"Converter Process in Steel Foundries,"* THE FOUNDRY, March, 1946, vol. 74, no. 3, pp. 83, 221-224.

This is the first of three articles in which the author discusses the use of the converter in making steel for castings. After pointing out the advantages of using converter steel to pour small lots of small or medium-size castings, the author describes the general procedure in operating a converter and discusses the role of silicon oxidation in raising the temperature of the molten metal during the blow.

NON-DESTRUCTIVE TESTING. (See *Inspection.)*

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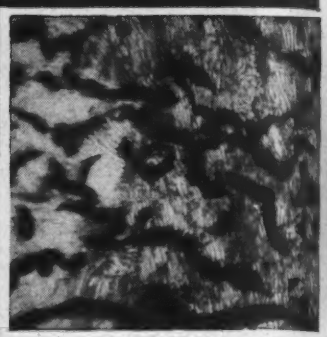

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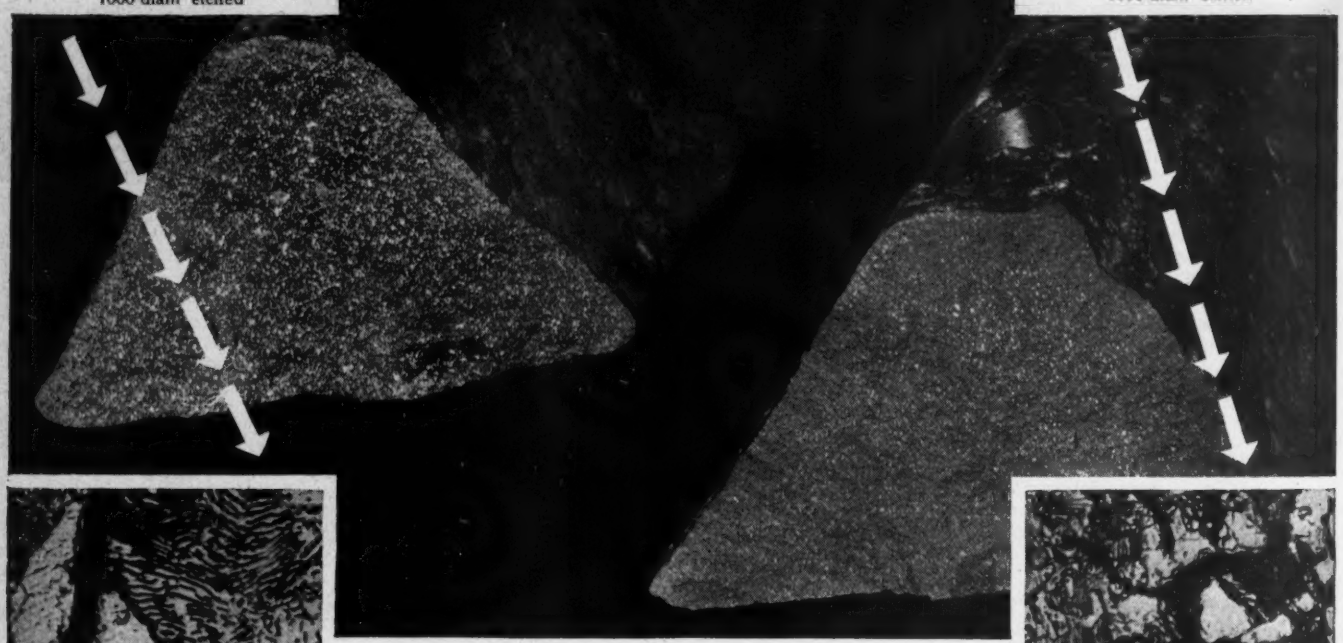

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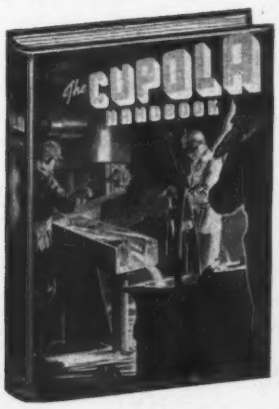

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Chapter Activities

(Continued from Page 92)

Co., Minneapolis; J. H. Richards, E. F. Houghton Co.; and Chapter Vice-Chairman H. M. Patton, American Hoist & Derrick Co., St. Paul, Minn.

Harry Blumenthal, district representative, R. Lavin & Sons, Inc., Chicago, reported on arrangements for attendance of chapter members at the National Convention in Cleveland, which were handled by Mr. Blumenthal and Shelly Pufahl, Paul Pufahl & Son Foundry, Minneapolis.

Rochester

D. E. Webster
American Laundry Machinery Co.
Chairman, Publicity Committee

PRIMITIVE FOUNDRY to modern foundry was the engrossing narrative unfolded before members of the Rochester A.F.A. chapter, meeting March 12, at the Hotel Seneca, Rochester, N. Y., as B. L. Simpson, National Engineering Co., Chicago, discussed the subject of his forthcoming book, "The History and Development of the Foundry Industry."

Mr. Simpson, nominee for A.F.A. National Director, traced the foundry from ancient times, accompanying his remarks with presentation of slides of illustrations to be used in the published work. Rude sandstone molds, crude box bellows, earliest patterns, and modern high speed production equipment were shown.

Cincinnati District

J. S. Schumacher
Hill & Griffith Co.
Chapter Vice-Chairman

IMPROVED CASTING FINISH through "Mold Atmosphere Control," was the subject of speaker of the evening Harry W. Dietert, Harry W. Dietert Co., Detroit, before the March 11 meeting of the Cincinnati District A.F.A. chapter, at Engineering Society Headquarters, Cincinnati.

The speaker, an active member of many groups in A.F.A. Foundry Sand Research Project, presented movies taken inside a dilatometer, which demonstrated effect of various atmospheres on metal penetration. Pointing out that this phase of molding control is new, Mr. Diet-

ert stated that its proper application can improve casting finishes greatly.

An interesting account of foundry problems in China was another feature of the meeting; with Ping Kao-Han, Industrial Development Co., Chungking, China, a member of the chapter, as speaker. Mr. Han described manufacture of a number of large castings, and revealed that it was necessary for Chinese foundrymen to build their own equipment; cupolas, cranes and flasks, before they could produce a casting.

Acting as presiding officers for the sessions were Chapter Chairman A. W. Schneble, Sr., The Advance Foundry Co., Dayton, Ohio, and Chapter Vice-President J. S. Schumacher, Hill & Griffith Co., Cincinnati.

Wisconsin

Walter Gerlinger
Walter Gerlinger, Inc.
Chairman, Publicity Committee

ORGANIZING an open forum when speaker of the evening Lester B. Knight, Lester B. Knight & Associates, Chicago, was delayed in reaching the March 8 meeting at the Hotel Schroeder, Milwaukee, members of the Wisconsin A.F.A. chapter held an animated and interesting discussion of foundry mechanization, under chairmanship of F. A. Pampel, Chain Belt Co., Milwaukee.

With arrival of Mr. Knight, who discussed "The Foundry of the Future," the meeting proceeded as originally planned. Members who were able to attend in spite of one of the most severe storms in Milwaukee history, demonstrated keen interest in the topic.

Central New York

J. A. Feola
Crouse-Hinds Co.
Chapter Reporter

PRINCIPLES OF DIRECTIONAL solidification applied to "Gates and Risers" for Sound Castings" concerned approximately 100 members and guests at the March 8 dinner meeting of the Central New York A.F.A. chapter, in the Onondaga Hotel, Syracuse, N. Y., as H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y., discussed the topic.

The speaker, Vice-Chairman of the Committee on Chill Tests, A.F.A. Gray Iron Division, and active on other National committees in that division, drew from his extensive background for recommendations in design of a system of gating and feeding applicable to a wide variety of sizes and shapes. Charts and slides, illustrating use of proportional gating and risering in the shrink-bob riser system, and its advantages over older methods in the production of sound castings, were presented.

Mr. Winte detailed features of the shrink-bob riser system, pointing out that it reduces cleaning costs considerably. Success of any riser depends on ability to feed hot metal into shrinking section of the casting, the speaker noted, adding that the shrink-bob riser design incorporates that feature and is new only in more completely establishing proper proportions and utilizing principle of gating through the riser.

Chapter Vice-Chairman E. E. Hook, Dayton Oil Co., Syracuse, introduced the speaker and presided at the meeting.

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Foundry Personalities

(Continued from Page 86)

by Whiting Corp., Harvey, Ill. Mr. Hermann, member of the A.F.A. Industrial Hygiene Codes Committee with a background of extensive experience in sales and engineering of dust collecting equipment, will make his headquarters at 1342 Harvard Road, Grosse Pointe Park, Michigan.

Robert C. Maentz, formerly in charge of Pittsburgh district refractory sales for Permanente Products Co., Permanente, Calif., has been named sales manager, Eastern Refractories Div., with headquarters at 1712 First Central Tower, Akron.

Serge P. Kovaleff has been named general sales manager, Enterprise Engine & Foundry Co., San Francisco. Mr. Kovaleff, who formerly served as plant superintendent for the firm, is a member of the Northern California A.F.A. chapter.

Norman A. Matthews, formerly Lieutenant Colonel, U. S. Ordnance Dept., has been appointed works metallurgist, Electro-Alloys Div., American Brake Shoe Co., New York, according to announcement by **W. G. Hoffman,** president of the division. Mr. Matthews, a graduate of M.I.T., served as director, Ferrous Metallurgical Laboratory of the Ordnance Department, and was awarded the Legion of Merit in recognition of his work.

Samuel Spilka, recently discharged from military service as warrant officer engaged in contract termination work, has been appointed assistant comptroller, Tel-Autograph Corp., New York, **Robert Spotts,** treasurer of the concern, announces.

American Steel Foundries, Chicago, has acquired the foundry of the Quad-City tank arsenal, Bettendorf, Ia., according to announcement by War Assets Administration. Land, buildings and equipment are included in the purchase.

Colgate Aircraft Corp., Amityville, Long Island, N. Y., fabricating and assembling firm, has purchased and will occupy the former **Grumman Aircraft Engineering Corp.** building at 14th St., near West Hoffman, Lindenhurst, Long Island.

Citizens Gas & Coke Utility, Indianapolis, has placed in operation a new battery of 47 coke ovens, manufactured by **Wilputte Coke Oven Corp.,** New York.

Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J., announces appointment of **Republic Supply Co. of Calif.** as distributor of Manhattan industrial rubber products on the West Coast, under supervision of **A. R. Bradshaw,** Manhattan's Pacific slope manager, San Francisco. **R. G. Hueman,** Manhattan factory representative, will make his headquarters at the Republic company, and will be available for consultation on mechanical rubber goods problems.

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Philadelphia, Pa.	Penna. Fdy. Sup. & Sand Co.
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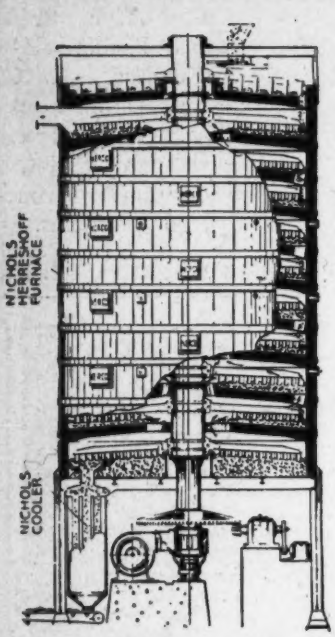

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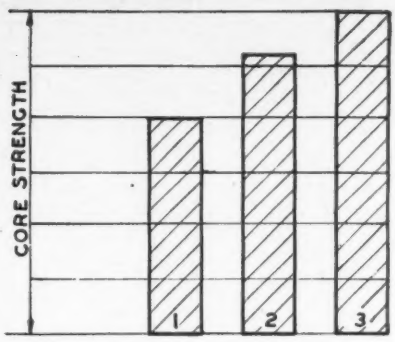

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New Literature

Peninsular Grinding Wheel Co., 727 Meldrum Ave., Detroit 7, is offering to the industry, without charge, 12 safety posters drawn by J. R. Williams, creator of "The Bull of the Woods."

Catalog No. 150, published by The Pyrometer Instrument Co., 103 Lafayette St., New York 13, describes an immersion pyrometer designed for the non-ferrous foundry.

A circular entitled "Opportunities for Productive Work Through Mineral Industries Research" has been published by The Pennsylvania State College, State College, Pa.

A new bulletin, F1603, released by Bristol Co., Waterbury 91, Conn., describes the features of the Bristol Bellows-Differential Flow Meter.

Dust control methods, principles, installations and "Roto-Clone" equipment are described in a greatly enlarged bulletin (No. 270-A) just issued by American Air Filter Co., Inc., Louisville 8, Ky. Air engineering data, many installation photographs, performance details, simplified procedure for designing a "Roto-Clone" exhaust system and discussion of pressure relationships in a duct system are included in the 36 page booklet, which is handsomely illustrated. Free on request.

Sand research data for application to a casting finish control plan are presented in the February *Foundryman's News Letter,* issued by Harry W. Dietert Co., Detroit 4, Mich. Various control equipment accessories are also pictured and discussed.

Practical applications of the "Cyclograph" in the foundry are described in Cyclograph Bulletin MTL P9, released by Allen B. DuMont Laboratories, Inc., Passaic, N. J. Basic principles of the instrument are discussed, and instances of its application in inspection of mal-

(Concluded on Page 108)

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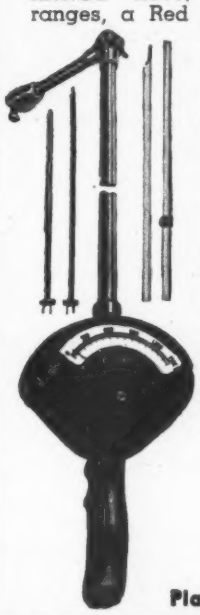

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